



USGS Patuxent Wildlife Research Center

Abstracts: Current Research Projects

September 1997 - February 1999



Evaluating the Effects of Environmental Contaminants on Populations, Communities, and Ecosystems

Peter H. Albers, Gary H. Heinz

Collaborators: W. James Fleming, Division of Cooperative Fish and Wildlife Units, Reston, VA
Kristin Brugger, DuPont Chemical Corporation, Gregory D. Foster, George Mason University

Research on the effects of environmental contaminants on wildlife is largely focused on the responses of individual organisms and their tissues. It is difficult to translate these results into effects at higher levels of organization. Natural resource managers and risk assessors need methods to project this information to populations and communities or improved methods to permit direct collection of the desired information. To meet these needs the USGS Patuxent Wildlife Research Center, the Society of Environmental Toxicology and Chemistry, and The Wildlife Society will cosponsor a symposium devoted to evaluation of the effects of environmental contaminants on terrestrial vertebrates at organizational levels above that of the individual. Theoretical and applied aspects of linkages among levels of biological organization, research methodologies, and opportunities for research development will be addressed by invited participants. Symposium attendees will participate in discussion groups following the critical reviews and case studies presented in each session. A Steering Committee representing the sponsoring organizations will plan and manage the symposium. Funding will be sought from government and non government organizations. The results will help biologists and managers interpret existing knowledge on the topic, and they will provide direction for future research.

Assessment of an Incident of Unusual Leg Deformities in Screech Owls from a CERCLA Site at the Department of Energy Savannah River Site

Peter H. Albers, David J. Hoffman

Collaborators: Lehr T. Brisbin, Jr., Savannah River Ecology Laboratory (SREL)
Travis Glenn, University of South Carolina

The discovery, in 1995, of severe leg deformities in a brood of screech owls nesting at a CERCLA site on the Department of Energy's Savannah River Site (SRS) generated concerns by EPA and FWS about the involvement of local radio nuclide and mercury contamination. Surviving members of the owl family were transported to Patuxent where they are being housed in the screech owl colony. Patuxent will characterize the leg deformity, and determine the mechanism of transmission and range of expression. If funding permits, staff of the Savannah River Ecology Laboratory will conduct a survey of physical abnormalities with a network of nest boxes on cooling water reservoirs at the SRS site and perform DNA analyses on SRS owls and Patuxent owls. The extent of genetic disruption, as manifested by the cytochrome-b gene of red blood cells or liver cells, will be viewed as an indicator of genotoxic influences at the SRS site. The results will enable federal resource managers and regulators to better interpret the potential for radio nuclides and mercury to affect DNA of wild birds.

Geomorphic Analysis of Storm Breaches and Barrier Island Dynamics in Northeastern U.S. National Seashores

James Allen

Collaborators: Peter August, Professor, University of Rhode Island
Charles LaBash, Research Associate, University of Rhode Island

This project is designed to identify and quantify storm-induced geomorphic changes to barrier island systems in northeastern US National Seashores and provide breach risk assessments for land managers. The study focuses on Cape Cod, Fire Island, and Sandy Hook units of the National Park Service. Digital versions of historical maps and photo coverages plus field surveys using GPS technology are used as input to GIS and statistical models of barrier changes and the role of storms, the persistence of inlets and their effects on the adjacent beaches, and the role of humans are all being addressed.

Completed

Beach Hydrodynamics and Morphologic Change of the Bayside Shoreline, Fire Island National Seashore

James R. Allen

Collaborators: Karl F. Nordstrom, Rutgers University
Douglas J. Sherman, Univ. of Southern California

This intensive month-long field experiment incorporated storms to assess storm-generated changes vis-a-vis low-energy conditions at the estuarine shoreline. Little is known about microtidal, low energy coastal dynamics yet the preliminary evidence suggests substantial erosion, in many cases equalling oceanside retreat. This study also includes a bayside retreat monitoring program including 14 stations along the Seashore to assess longer-term change trends. Extensive data reduction and complex analysis needs require a long, post-experiment period.

Completed

Dune Crest Mobility at Fire Island National Seashore, New York

James R. Allen

Collaborators: Norbert P. Psuty, Rutgers University

This study is designed to update the Dune District reference baseline (i.e., dune crestline) within the populated communities of Fire Island National Seashore and to extend the dune crestline maps into natural ecological zones, and analyze the spatial patterns of change for systematic and stochastic causes. The discovery of systematic patterns would allow for prediction of future dune threats island-wide. The study relies on photo interpretation. Additionally, an annual cross-shore survey at 28 stations adds elevational and volumetric data for 1984 to present.

Completed

Numerical Modeling of Fire Island National Seashore Breach Impacts Upon Circulation and Water Quality of Great South Bay, NY

Daniel C. Conley, SUNY-Stony Brook

Collaborators: James R. Allen

This study is designed to obtain present data on tidal and storm driven circulation patterns in Great South Bay (NY), and to use them to calibrate a numerical model. The model will be a finite difference type with a nested grid at existing inlets and likely sites for new storm breaches in the barrier island. The model will simulate circulation patterns resulting from breaching at the likely locations and calculate effect upon new storm water levels, new estuarine flow fields and their velocities, assess sediment redistribution potentials, and estimate whether the breach will close naturally or remain active.

Field Measurements and Calibrated Circulation Model within the Nauset Marsh Estuary, Cape Cod National Seashore

David Aubrey and Wayne Spencer, Woods Hole Oceanographic Institution

Collaborators: James R. Allen

This study is designed to obtain field data required to develop and implement a numerical model of circulation with Nauset estuary, Cape Cod National Seashore. Both single and multiple inlet states will be modeled. Changes in inlet configuration affect estuarine circulation and its dependent resources. Another focus is on the flushing rate of Town Cove (a portion of the estuary) to assess the limits upon groundwater delivered nutrients and their affects upon the estuary. Ten instrumented sites provide spatial variations in the tidal components of depth, temperature, and salinity. Deep coves contain vertically sampled CTD profiles. GPS controlled bathymetric and shoreline surveys provide accurate boundary conditions for model and barrier island changes.

Systematics and Distribution of American Birds

Richard C. Banks

Studies on the systematics and distribution of American birds provide information that can be used to manage population segments for particular purposes. They provide knowledge of relationships of populations and taxa, and provide grist for the mills of biological geographers and evolutionists. Studies of geographic variation allow names to be associated with geographic sub-populations with distinctive characters. For example, although it is an important game species, the Greater White-fronted Goose has never been the object of a comprehensive study of geographic variation. As a result, no two major references use the available sub-specific names in the same way--and it appears that none uses them properly. Currently, studies of geographic variation, species limits, and/or nomenclature are in progress for certain gulls, pheasants, hummingbirds, flycatchers, and owls, as well as the major study of white-fronted geese.

Role of Sediment Ingestion in the Exposure of Chesapeake Bay Wildlife to Environmental Contaminants

W. Nelson Beyer

Lead poisoning of waterfowl has been attributed in the past to the ingestion of lead shot or sinkers. Recent investigations at highly contaminated sites show that the incidental ingestion of sediments can also poison waterfowl. Digesta and feces collected from several waterfowl species were analyzed for sediment markers, and the results showed that some species ingest a lot of sediment and that this sediment was the main source of lead in waterfowl diets. Aluminum, iron, and acid-insoluble ash were all useful markers of sediment that were correlated with lead. Feeding studies on mute swans demonstrated that sediment-borne lead was biologically available and toxic to waterfowl. Collections of mute swans from Chesapeake Bay are being used to develop a model relating sediment ingestion to exposure. Collections of 50 hunter-killed waterfowl from Prime Hook Refuge will expand the conclusions to additional waterfowl species. Mute swans will be collected from the Aberdeen Proving Grounds to study the uptake of arsenic from a contaminated site. The results of all of these studies will be used to develop a risk assessment model to evaluate contaminants in sediments.

Completed

Determine Mercury Concentrations in Florida Sandhill Cranes, Anhingas, and Other Wildlife/Wading Birds from Florida Refuges

Nelson W. Beyer, Dan D. Day, Anna Morton

High concentrations of mercury have been thoroughly documented in game fish in South Florida. In 1989 a Florida panther was found dead, possibly from mercury poisoning. This study was designed to determine which other species might be at risk of mercury poisoning. Apple snails, the primary food item of snail kites and limpkins in the Everglades, were sampled in southern Florida. The highest concentrations of mercury in snails were from waters south of Lake Okeechobee, but none of the concentrations were as high as those reported in bass from the same waters. Mean mercury concentrations in feathers of wading birds were sampled and were found to be greatest in great egrets, followed by great white herons, great blue herons, and roseate spoonbills. Mercury concentrations detected in livers suggested that wood storks have high exposure to mercury. Mercury was also analyzed in 180 eggs of wading birds. The concentrations detected in anhingas, which are piscivorous, are close to those associated with reproductive impairment in mallards under laboratory conditions. Sandhill cranes, which are omnivorous, had low concentrations. The final part of this study is a review of mercury wildlife data collected on refuges in Florida, to identify those species at greatest risk from mercury poisoning. The work is being carried out with the cooperation of biologists from the University of Florida, the U. S. Fish and Wildlife Service, and the National Park Service.

Development of a General Model for Evaluating Damage to a Soil Ecosystem from Environmental Contaminants and Other Stressors

Nelson W. Beyer

Eco-toxicologists are sometimes asked to evaluate ecological damage at contaminated sites. They may be able to quantify high concentrations of environmental contaminants in soil and may observe faunal changes that suggest the functioning of the soil ecosystem has been disrupted, but be unable to state that the observed changes should be considered damage to the soil ecosystem. Soil organisms are so numerous and diverse that it is impractical to use population estimates as a measure of damage to soil processes. The purpose of this work is to develop a simple means of identifying damage, as distinct from change, by examining the distribution of organic matter in a soil profile. It is suggested that the distribution of organic matter responds to the long-term functioning of the soil. Further, it is suggested that because the distribution of organic matter in soil affects primary productivity, it could be used as a measure of soil quality and it is a meaningful variable to consider in ecological assessments.

Development of a Spatially-explicit, Individual-based Model to Simulate Kirtland's Warbler Population Dynamics

Carol I. Bocetti

Collaborators: Jonathan Bart (USGS/Biological Resources Division - Raptor Research and Technical Assistance Center)

The Kirtland's warbler (*Dendroica kirtlandii*) is an endangered species that breeds in the jack pine (*Pinus banksiana*) plains of north central Lower Peninsula Michigan and winters in the Bahama Island archipelago. The natural pine barren ecosystem was historically maintained by frequent wildfires, but due to modern fire suppression techniques and alternative land uses, the amount of this habitat has decreased causing the decline of the Kirtland's warbler population. In addition, the warbler population was decreasing due to cowbird parasitism. In 1972, land managers began to trap cowbirds, and in 1976, they began to plant jack pine to replicate wildfire habitat. The warbler population stabilized, and since 1987 it has steadily increased as the amount of suitably-aged habitat has increased. In addition to habitat management, biologists have studied habitat use and demography of the species. Researchers now have estimates of demographic variables such as age- and sex-specific survivorship, pairing success, fecundity, and dispersal rates. The data can be used to tailor a population viability analysis (PVA) model specifically for the species. The Kirtland's Warbler Recovery Team has requested that a PVA be constructed to assist in the revisions of the habitat management plan and to re-evaluate the recovery goals and strategies. In this study, we 1) develop a spatially-explicit, individual-based model, 2) validate the model by comparing simulated population estimates to known population estimates through time, 3) use the model to assist resource managers in evaluating alternative management scenarios, and 4) estimate age-specific and sex-specific dispersal rates.

Assumptions and Caveats Underlying Population Viability Analysis

Carol I. Bocetti, Jeffrey S. Hatfield

Evaluation of Population Viability Analysis: Population viability analysis, a Monte Carlo computer simulation of population dynamics, is used as a quantitative tool to investigate management options for rare or endangered populations or species. Before performing a population viability analysis, many choices must be made concerning model design and procedures. These choices include model selection (commercially available software such as RAMAS, VORTEX, or ALEX or simulations programmed in house); the duration of the simulations; how many replications to run; the number of age classes to simulate; and whether to include spatial structure in a meta population. Prior to the simulations, data must be properly collected and analyzed to estimate the mean fecundity, survival, and dispersal rates for each age class. Also, temporal variances must be estimated and statistical distributions (e.g., normal or lognormal) must be chosen for fecundity and survival rates. We ran experimental simulations using golden-cheeked warbler data to evaluate the importance of these choices. The evaluation is intended to assist biologists in field offices by providing advice on how to make informed decisions concerning the many choices required before actual simulations are performed. We present results showing how the estimated probability of extinction for golden-cheeked warblers is affected by some of these choices. Results show that a minimum of 1000 replications should be run, especially at low (1 - 5%) probability of extinction. Also, the choice of normal versus lognormal distribution of parameters is important in RAMAS and VORTEX. The software truncates the distribution of survivorship to be between 0 and 1. Under a normal distribution this is a two-sided truncation process, which inflates survivorship rates entered as less than 50% and deflates those greater than 50%. This effect becomes more significant as variability in the model increases.

Calculation of Temporal Variance: Temporal variation of demographic characteristics for animal populations are of interest to both ecologists and biological modelers. The standard deviation of a series of estimated parameter values (e.g., estimated population size) is commonly used as a measure of temporal variability. This measure of temporal variation overestimates the true temporal variation by not accounting for sampling variability inherent to the estimation of unknown population parameters. Using a variance-components approach to partitioning the total variability of an estimated parameter, we removed the sampling variation from the observed total variation of survival estimates for three avian species: the federally listed roseate tern (*Sterna dougallii*), black-capped chickadees (*Parus atricapillus*) and mallard ducks (*Anas platyrhynchos*). Sampling variation accounted for the majority of the total variation in the survival estimates for nearly all of the populations studied. Substantial differences in observed significance levels were observed when testing for demographic differences in temporal variation using temporal variance estimates adjusted and unadjusted for sampling variance.

Impacts of Selective Tree Harvesting on the Delmarva Fox Squirrel

Carol I. Bocetti, Oliver Pattee

The Delmarva fox squirrel (*Sciurus niger cinereus*) is an endangered species found only in remnant patches of its former range. Fragmentation of its preferred habitat and changes in silvicultural practices on the Delmarva peninsula pose serious threats to its stability. Its decline is being mirrored by most, if not all, of the eastern subspecies of fox squirrels. The demographics of the Delmarva fox squirrel in relation to forest age and stand conditions are unknown and management practices to produce and maintain suitable forest habitat are untested. The immediate objectives of this study are 1) to investigate the impact of selective tree harvest on the density, productivity index (subadult:adult ratio), age- and sex-specific survivorship and dispersal rates, and habitat correlates for Delmarva fox squirrels, 2) to refine and standardize data collection and survey techniques for squirrels, and 3) to consolidate and analyze available databases and make them accessible to all cooperators. Three 40-acre plots will be established on the Chesapeake Bay Demonstration Forest, owned by The Conservation Fund, where a selective tree harvest will occur in the summer of 1998. Three reference sites (no timber harvest) will be established in similar habitat on Blackwater National Wildlife Refuge land. Trapping and tagging protocols will follow those recommended in the Delmarva fox squirrel recovery plan. Vegetative composition will be determined by two separate methods, one of which is recommended in the recovery plan and used to develop a habitat suitability index (HSI). Vegetation data will be used to evaluate the HSI model's precision and accuracy in determining optimal squirrel habitat. Ultimately, the habitat model will be correlated with squirrel density and demography; the goal being a spatially-explicit model that can be used by land managers to evaluate the impact of various land-use options.

Assessing Declines in Neotropical Migrants at Fire Island National Seashore: Phase II - Replication of 25-Year Old Sampling and Estimation of the Relationships Among Migrating Birds, Mammals and Ticks in the Ecology of Lyme Disease

P.A. Buckley

Collaborators: Howard Ginsberg, H. Brian Underwood

The major aims of this study are to 1) quantify any changes in number of neotropical migrant birds that have occurred over the last 25 years at the undeveloped Lighthouse Tract of Fire Island National Seashore, and 2) quantify the contributions of all common vertebrate species, including residents and migrants, to spirochete infection in nymphal *Ixodes scapularis* (deer ticks) the primary vector stage of human Lyme disease. Changes in migratory bird species richness and abundance at the Lighthouse Tract will be assessed by mist-net sampling and comparing the findings with similar samples taken at the same Fire Island Lighthouse site from 1969-1972. The influx of deer ticks and spirochetal infection into the site on migratory birds will be estimated and compared to estimates of resident questing ticks, ticks on resident mammals and birds, and influx of ticks on dispersing mammals. This study will assess changes in populations of neotropical migratory birds over the past quarter century and provide information that can be used to reassess and improve currently-available management techniques for ticks and Lyme disease.

Landscape Planning to Retain Breeding Forest Birds in a Fragmented Environment

Deanna K. Dawson

Collaborator: Chandler S. Robbins

Habitat for forest-nesting birds in suburban Maryland and in other metropolitan regions of the Eastern U.S. is declining as forests are converted to other uses. To ensure that breeding populations of forest-nesting birds are retained, planning is required to identify forests that should be priorities for preservation, and to develop strategies to preserve them while opportunities still exist. Bird survey data from more than 600 forests in Prince George's County, Maryland, are being used to develop models that predict the occurrence of bird species in forests. The predicted probabilities of occurrence are being integrated with forest cover data for the County in a Geographic Information System to map the distribution of individual bird species and richness of area-sensitive species (i.e., species whose probability of occurrence in forests increases with forest area). This information is being used in combination with local zoning and forest conservation requirements to develop a forest conservation plan for Prince George's County that protects and enhances breeding habitat for area-sensitive forest birds while allowing for suburban development that is expected to occur as human populations increase.

Conservation of Wintering Habitat for Neotropical Migrant Birds on a Newly-created Private Nature Reserve in Campeche, Mexico

Deanna K. Dawson, Marcia H. Wilson

Collaborators: Paul Wood, Merida, Yucatan, Mexico, and College of Environmental Science and Forestry, State University of New York, Syracuse, New York

Conservation of neotropical migrant birds requires conservation of their habitats, both in North America and in the tropics, yet few opportunities exist for direct involvement in avian habitat conservation outside the United States. Since 1992, avian research has been conducted by the Patuxent Wildlife Research Center on Rancho Sandoval, in Campeche, Mexico. This 10,000-hectare property, which consists of a mosaic of forests and pastures, and extensive areas of savanna, was established as a private nature reserve in 1993. Although cattle ranching will continue on a portion of the reserve, conservation and enhancement of biological diversity are the management priorities. In 1996, the National Fish and Wildlife Foundation, under the Neotropical Migratory Bird Conservation Initiative and through a cooperative agreement with the U.S. Agency for International Development, awarded a challenge grant to Fundación Sandoval Caldera to develop a conservation and management plan for Rancho Sandoval. The Plan is being developed in collaboration with PWRC biologists and Mexican biologist Paul Wood, a master's degree student at the College of Environmental Science and Forestry, State University of New York-Syracuse. A Geographic Information System has been developed that includes coverages of habitats and land uses on Rancho Sandoval. The GIS and previously collected point count data (Study 50010.01) were used to design a survey of the avifauna in the major habitats. Data on bird species' abundances will be integrated in the GIS to identify habitats used by migratory and rare resident bird species. This information will serve as the basis for developing a Conservation and Management Plan for Rancho Sandoval that protects and enhances habitats for birds and other wildlife, while allowing for limited cattle ranching or other activities that would provide an economic return. As such, the reserve can serve as a model for other ranches in the region to promote compatible and sustainable land use in conjunction with wildlife habitat preservation.

Dynamics of Populations of Breeding Forest Birds in a Fragmented Suburban Landscape

Deanna K. Dawson

In many metropolitan regions, the existing forest consists predominantly of relatively small forest tracts that are becoming increasingly isolated from similar habitat by residential, commercial, and industrial development. Populations of bird species in these forests are generally small and may be subject to temporary extinctions and colonizations by birds dispersing from other sites. In this study, we will model the patterns of forest patch occupancy by forest-nesting bird species, given possible scenarios for change in the area and spatial distribution of forest in Prince George's County, Maryland. Previously collected data on bird populations (study 50001.01) will be used to estimate the probabilities of local extinction and colonization in forests for the set of "area-sensitive" species, those whose probability of occurrence in forests increases with forest area. Additional bird counts will be conducted to provide sufficient data to identify site and landscape characteristics that are associated with these probabilities, and to model bird response to forest change. Potential changes in forest area and isolation under current zoning and land ownership will be mapped and measured by applying local forest conservation requirements to forested properties in a Geographic Information System. The study is aimed at assessing the effect of forest fragmentation on forest-nesting birds, and will lead to recommendations for focusing forest conservation efforts in suburban landscapes.

Population Dynamics of Neotropical Migratory Birds using Agriculture-Forest Mosaics in Southern Mexico

Deanna K. Dawson

Populations of several species of neotropical migratory birds are declining. The regulatory mechanisms for population declines are poorly understood because demographic information is lacking for many bird species. Although general habitat associations have been documented for many species on the wintering grounds, little is known about persistence and survival of migrants in various habitats. In 1992, research on population dynamics of migratory and resident birds was initiated on Rancho Sandoval, a private nature reserve in Campeche, Mexico. Bird populations are sampled with mist nets and point counts on six 12-ha study plots, three in forest and three in adjacent pasture. Over 12,000 birds of 160 species have been banded during 18 sampling periods; roughly 42% of the birds banded are migrants (47 species). Data are being used to estimate survival probabilities and habitat/site fidelity for species, and to document temporal and spatial variation in the distribution, abundance, richness, and detectability of bird species. Results will allow a test of the association between trends in breeding populations of migratory species and their over-winter and annual survival probabilities. Comparisons of survival and movement probabilities between habitats and among species will enable us to evaluate the relative importance of forest and pasture habitats to birds, and to identify species most likely to be impacted by land use changes. Estimates of species' richness and detection probabilities will be used to determine the optimal methods and season for sampling populations of migratory and resident birds. This information can be used for designing future avian monitoring programs in the tropics.

**Modeling the Distribution, Abundance, and Habitat Associations of
Cerulean Warblers and other Forest-nesting Birds
at the US Military Academy, West Point, NY**

Deanna K. Dawson

The Cerulean Warbler (*Dendroica cerulea*) has been identified as a species of management concern (US Fish and Wildlife Service 1987) because of declines in breeding populations. In this study, bird populations are surveyed on the 6500-ha property of the US Military Academy (USMA), West Point, New York, to document the distribution, abundance, and habitat associations of Cerulean Warblers and other forest-nesting birds. Two survey designs, a systematic sample and a habitat-based sample, are being compared for their effectiveness in detecting and modeling the occurrence and abundance of Cerulean Warblers, which are relatively rare and patchily distributed. The study will provide information that will be used by USMA biologists to develop conservation plans for Cerulean Warblers and other bird species of interest, and can serve as a baseline for future monitoring of bird populations on USMA property. In addition, study results should provide useful guidelines for designing surveys of Cerulean Warblers or other rare bird species in other areas.

**Development of New Monitoring Techniques and Programs
for Plants and Animals**

Samuel Droege

This task will explore at the pre-project level the statistical validity of existing monitoring programs and search out useful new target taxa for measuring environmental change. Existing monitoring programs will be evaluated for their statistical robustness and bias, and recommendations will be made as appropriate for developing projects aimed at improving sampling designs. Monitoring programs will also be evaluated on the basis of their relative costs and their relevance as indicators of environmental change at the park, refuge, state, or continental levels, as appropriate. Plant and animal groups not presently monitored will be statistically evaluated for their relevance in as bioindicators. For these groups new sampling methods will be developed. Methodological development and consultation on implementation may involve participants from federal governments, state/provincial natural resource groups, National Parks, National Wildlife Refuges, academia, non-government agencies, and the public.

North American Amphibian Monitoring Program

Samuel Droege

This project will create a continent-wide set of surveys for amphibians using the statistical tools of power analysis and validation studies to evaluate monitoring techniques. Development and implementation will involve participants from federal governments, state/provincial natural resource groups, National Parks, Wildlife Refuges, academia, non-government agencies, and the public. A database on amphibian population declines will also be produced, including a web-based bibliography of scientific references on amphibian populations and monitoring, and distribution and species richness maps for amphibians of the eastern U.S., emphasizing the mid-Atlantic highlands.

Standardized Monitoring Methods for Amphibians in National Parks and Associations between Amphibian Abundance and Environmental Stressors

Sam Droege

Collaborators: Robin Jung and John R. Sauer

Increasing reports of amphibian declines and deformities necessitates monitoring amphibian populations and investigating correlational and mechanistic links between amphibian abundance and health and natural and anthropogenic stressors. Amphibians may be particularly susceptible to environmental stressors such as contaminants and ultraviolet radiation because of their permeable skin, gills, and eggs, and complex life cycles with terrestrial and aquatic stages.

The primary goals of the Amphibian DISPro (Demonstration of Intensive Sites Program) project will be to 1) develop and validate monitoring protocols for amphibians, and 2) investigate relationships between environmental factors and the distribution, abundance, and health of amphibians at Big Bend and Shenandoah National Parks. Research objectives include:

- 1) developing standardized and efficient monitoring protocols for Big Bend and Shenandoah National Parks which could be applicable to other Parks of similar environments and serve as bases for long-term monitoring;
- 2) evaluating bias and efficiency of various amphibian sampling methods and validating population indices using mark-recapture techniques;
- 3) mapping the distribution and abundance of amphibians in each Park using GIS, and investigating spatial and temporal relationships between environmental factors and amphibian population parameters;
- 4) conducting field experiments to directly test relationships between environmental stressors (ultraviolet radiation, prescribed burns, contaminants) and amphibian population parameters.

Contaminant Hazard Reviews and Other Information Transfer Documents

Ronald Eisler

The **Contaminant Hazard Reviews** series has become an important reference tool for contaminant specialists, scientists, teachers, federal and state managers of natural resources, industrial consultants, and the public. More than 96,000 copies of individual reports are now in circulation in response to specific requests. Each report involves critical review of the technical literature of a subject selected after consultation with cooperators and colleagues, a unique format developed by the author, and extensive peer and editorial review. Typically, subtopics covered include contaminant sources and uses, environmental chemistry, concentrations in field collections of abiotic materials and living organisms, lethal and sublethal effects (including deficiency if applicable), proposed criteria for the protection of human health and sensitive natural resources, and recommendations for additional research. Publication is through the U.S. Department of the Interior's Biological Science Report series, and distribution is through the Publications Unit of the Geological Survey, the National Technical Information Service, the author, and (soon) electronically by CD ROM disc. Current projects include **Contaminant Hazard Review** reports on "Copper" and on "Nickel", a book chapter entitled "Sodium cyanide hazards to fish and other wildlife from gold mining operations", preparation of a CD ROM disc of the first 27 reports in the **Contaminant Hazard Reviews** series, and preparation of a book "Priority contaminant hazards to fishery and wildlife resources".

**Develop Methods to Establish New, Less Dangerous Migratory Paths
for Cranes Using Surface Vehicles, Ultralight Aircraft,
and Other Guiding Devices**

David H. Ellis, George F. Gee, Glenn Olsen

Collaborators: William Lishman, Operation Migration, (actual leader of ultralight project)
Joseph Duff, Operation Migration
Richard Urbanek, U.S. Fish and Wildlife Service, Region 3
William Sladen, Environmental Studies, Airlie Center

This project seeks to develop new reintroduction techniques for extirpated species. Some techniques will involve training juvenile birds to follow motorized craft. These techniques require not only following novel artificial stimuli, but will ultimately involve translocating non-trained birds to determine if they will follow those already trained to follow motorized craft. Our study species at the onset is the sandhill crane, but techniques holding promise are soon to be applied to the whooping crane, with application to Asian cranes and swans likely. Immediate and long-term ramifications are unlimited. So far we have learned to imprint cranes to follow motorized craft over long distances and have seen a few birds return to our chosen wintering and summering areas unassisted.

**Application of Satellite Telemetry and Satellite Imagery
to the Conservation of Endangered Species**

David H. Ellis

Collaborators: Patrick Coronado, NASA/Goddard, Chief Engineer for Information Sciences

This project applies satellite telemetry and satellite imagery capabilities to habitat use patterns and long-term or long-distance movements of wildlife. Sub-projects include Eurasian crane satellite telemetry, Siberian crane satellite telemetry, harpy eagle dispersal and habitat use via satellite telemetry, sandhill crane satellite telemetry, steppe eagle migration via satellite telemetry, lesser spotted eagle migration via satellite telemetry, Wahlberg's eagle migration via satellite telemetry, and development of techniques to lead cranes on migration with motorized vehicles including two ultralight projects and a trucking project. Subprojects just beginning include Madagascar fish eagle post-fledging dispersal, condor long distance movements and *Cinereus* vulture long distance movements.

Assessing the Relative Habitat Value of Restored Versus Natural Coastal Marshes to Migratory Birds in Chesapeake Bay

R. Michael Erwin

The US Army Corps of Engineers has a national program entitled the "Beneficial Use of Dredged Material" program that has as its mission using dredged material disposal in such a manner as to enhance wetland areas for use by fish and wildlife resources. Several of these are designated in the Chesapeake Bay on islands. The latest approaches encourage the use of geotextile tubes instead of riprap and hard surfaces as containment dikes. We proposed to conduct research to evaluate the use of such created wetland sites by migratory birds relative to those of natural, control marsh sites. Such sites could potentially be used for nesting by certain shorebirds such as Willets (*Catoptrophorus semipalmatus*) and colonial species such as Least Terns (*Sterna albifrons*) and Common Terns (*S. hirundo*). Several years may be required before the project is completed and before vegetation becomes established. Sites require monitoring over a series of years to determine their success. The results of the monitoring effort over time should provide insights into ways to improve the wetland development/dredge disposal protocols for the benefit of wildlife. Methods that provide sufficient elevations to avoid frequent flooding while at the same time minimizing the invasion of common reed (*Phragmites communis*) will receive focus. To date, work has been initiated at Smith Island, Fair Island, and Poplar Islands in Chesapeake Bay. At the first two sites, problems associated with geotextile tube installation rendered the sites too exposed to wave action so that sand and vegetation were constantly being shifted. Wildlife use therefore has been minimal. At Poplar, data were collected at marsh reference sites, and the remnant islands, on nesting and feeding birds in 1996. Funding was provided by the USACOE for this first phase. The construction phase is to begin in summer 1997. A report was provided to the Maryland Environmental Service based on the 1996 monitoring of the Poplar group.

Completed

Low Productivity in Declining Populations of Gull-Billed Terns: The Roles of Food Limitation, Habitat, and Predation

R. Michael Erwin

The Nature Conservancy owns 13 of 18 large barrier islands and associated marshes along the nearly pristine Virginia eastern shore in one of the few Atlantic coastal regions without major human developments. Since the mid 1970s colonial waterbirds have been monitored during the nesting season as part of the TNC stewardship program. Declining trends have been noted for a number of waterbirds, including the gull-billed tern, *Sterna nilotica*, and black skimmer, *Rynchops niger*. Research was needed by the TNC, state, and USFWS to determine reasons for these trends. Pilot studies began in summer 1994 to try to estimate reproductive success of the terns at several sites on both marsh and barrier island sites. These studies continued in 1995 and 1996. In addition, some data were also collected on prey being fed to young. In 1997 funding was received to augment the habitats at selected sites to try to reduce flooding losses, a major source of nesting failure in the three previous seasons. We plan to analyze results and determine the relative impacts of flooding, predators, and other factors as mortality sources. These results should allow us to make management recommendations to The Nature Conservancy, the major client. The outcome of the research should allow us to make recommendations to the land managers concerning the advisability of altering habitat for terns, eg. Adding shells to increase elevation of sites, or removing predators to reduce either mammalian or avian predation. The results will indicate which specific habitats are used in a reliable way from year to year, and which are ephemeral. They will also allow us to evaluate potential sources and sinks of habitat/colony sites which may affect protection or acquisition strategies.

Selected Bird Species Nesting in Jamaica Bay Wildlife Refuge

R. Michael Erwin

Jamaica Bay Wildlife Refuge, a unit of the Gateway National Recreation Area in metropolitan New York, is an area of great potential for waterbirds: it supports large numbers of nesting gulls and wading birds, feeding shorebirds in migration, and wintering waterfowl and other waterbirds. The area is adjacent to JFK International Airport and thus has a history of bird-aircraft interactions. For this reason, an ongoing tension exists between the NY-NJ Port Authority and the National Park Service in supporting wildlife, specifically the Laughing Gull. The Port Authority would like the NPS to eliminate the large gull colony near the runway, while the NPS maintains that this is the only viable colony of this species in New York. Further, it argues that local nesting gulls are not the airstrike hazard, but rather non-breeders from outside the state. While the ADC currently has permits to shoot all 3 species of gulls, the NPS has asked BRD to conduct research on the nesting ecology, movements, habitat selection, and diet of Laughing, Herring, and Great Black-backed Gulls and to identify sources of nesting mortality. Although earlier studies have been conducted on movements of birds near the airport, conditions have changed; the large landfills are closed, runway maintenance has been altered, and other off-refuge attractants have been decreased. The field work underway is being coordinated by the New York Cooperative Research Unit, with a post-doctoral student acting as the field supervisor and an MS student both based in New York. Patuxent Wildlife Research Center plays the role of oversight for the project and provides logistical support and technical review of the project. Results from the research should indicate whether nesting success is high enough to result in population increases of the species, how much potential nesting habitat for each species of gull in the Refuge, major sources of mortality of nesting gulls, primary attractants to feeding gulls both in the Bay and at selected sites near the airport, and reveal the primary prey being taken by gulls by season. The research should help the NPS managers determine whether moving the gull colony is a necessary and desirable alternative in a waterbird management plan relative to airport concerns for safety. The results will be presented to both the management and academic community.

Completed

Developing a Herpetofaunal Atlas and Inventory Protocol

Michael Erwin, Sam Droege, Jeff Hatfield, Jim Nichols

This project, the first of the NBS State Partnership initiatives, focuses on the declining amphibian problem and capitalizes on the state of Maryland's interests in amphibian-reptile atlas. Major objectives include: 1) comparing two methods for capturing or recording amphibians and reptiles in the four regions of the state, and 2) to determine the efficacy of using volunteers to collect field data in an atlas effort to take place in 1998 +.

Completed

Development of Patuxent Long-term Monitoring and Ecological Research (PALMER) Project

R. Michael Erwin

The need to understand how biological resources change through time on the lands managed by Department of Interior agencies is often raised. Understanding whether changes in animal or plant populations result from human perturbations or from natural causes has major implications to the way resources are managed. Many parks, refuges, and national forests are establishing long-term monitoring programs for certain biological and physical resources. At National Wildlife Refuges, managers need to be able to implement management programs and then evaluate their success through time. At the Patuxent Research Refuge, a great opportunity is available because of the joint programs of research on the grounds coupled with more traditional refuge management. This creates an opportunity for researchers to collaborate closely with refuge managers to more effectively evaluate changes in populations and make adaptive changes in management. The PALMER project proposes to (1) compile all available long term data sets into a GIS for the Center, and to generate maps at different scales for resource planning, (2) continue to collect long-term data on birds, and other fauna and flora, and (3) use the results from (2) to make management recommendations for the refuge. The expected outcome of the PALMER effort is that a database will be established and maintained that will contain information about the many long term biological resource monitoring and research efforts conducted at Patuxent since the 1940s. This will include a bibliography on published studies based at Patuxent. In addition, monitoring will continue on birds, amphibians, tree dynamics, box turtles, and other taxa. An immediate need is to both supplement the old grid marker system on the Central Tract at PWRC, as well as creating new grid systems on North and South Tracts. This will enable all biological resource data for the entire refuge to be geo- referenced in the future. Having this long-term biological data and knowing its spatial location will enable more effective and timely land-management decisions. Establishing a GIS for the refuge will allow rapid mapping and decision making regarding land use operations and activity planning.

Completed

Developing a National Colonial Waterbird Database

R. Michael Erwin, Brett Hoover

Since the National Audubon Society terminated support of the National Colonial Bird Register at Cornell University in the late 1980s, there has been no comprehensive nationwide program to monitor colonial waterbirds. Through a series of workshops held at meetings of the Colonial Waterbird Society, an effort began in 1988 with US Fish and Wildlife Service support to re-inventory the coastal areas monitored during the OBS program period (1975-80), including the Great Lakes, Atlantic, Gulf, and West coasts of the US. Patuxent's role has been one of providing technical advice in developing the protocols and communicating technical details. Also, since about 1993, it has assumed the role of data management for the Atlantic coastal inventory. This is to serve as the basis for a wider, national effort. The concept in this program is that the states will conduct surveys (largely with their own funding) and provide electronic copies of the data to Patuxent. Patuxent staff will then store the information, provide summaries of the state and regional data, present summaries on the web, and conduct analyses of population trends, and distributional changes. This service will allow a regional and national evaluation of the status of as many as 55 species and greatly extend what individual states are capable of providing. This will provide state, regional and national status and trends of nesting populations of up to 55 species of colonial waterbirds in the United States. These data should be useful to natural resource and land managers concerned with siting of potential developments, contaminant assessments, environmental impact analyses, watershed management planning, or researchers concerning with specific populations of waterbirds. To date, the field data collection, compilation, and assessment of all Great Lakes data (collected 1989-1991) is complete and data are in electronic form at Region 3 and Washington headquarters offices. Some have been entered into a GIS. The Atlantic coastal inventory has completed its field phase and nearly all data have been submitted to PWRC. These data include field collections from 1993-96 from Maine to Georgia. Plans are underway for an agreement to be signed between the USFWS and PWRC concerning the relative federal roles in this effort. After that is complete, a comprehensive colonial waterbird conservation plan will be developed with a number of state, federal, and NGO stakeholders. Preliminary plans are underway for a Gulf coast effort to begin in 1998.

Ecosystem Dynamics on a Coastal Landscape

R. Michael Erwin

This synthesis effort is part of a large Long Term Ecological Research program at the University of Virginia. The project is to develop a synthesis volume to summarize and evaluate all of the 10 years of data collection in the Virginia Coast Reserve. Such volumes are expected by the National Science Foundation of all LTER programs about every 10 years. Our primary focus is on plant and animal communities and biogeographic patterns at a large scale in the VCR. We plan to use the existing vegetation, mammal, herp, and bird data collected since the 1970s to determine within and among island patterns relative to diversity and disturbance gradients. Landscape level analyses should reveal the overall determinants of patterns, whether they be barrier island-mainland patterns, or longitudinal patterns. The effort should also reveal where important research and monitoring gaps occur. The purpose of the effort is to synthesize all of the ecological, geological, hydrological, and atmospheric information into one volume to assess the relationships among the physical, chemical, and biological patterns and processes in the Virginia barrier island landscape. The effort should help reveal where further work is needed to lend more strength to structural and predictive modeling in the system. Long term changes in sea level rise and frequency and strength of coastal storms are two examples that will have major effects on long term dynamics of plant and animal communities in the region. To date, three preliminary meetings have been held to discuss the plans for 1-2 chapters with three co-authors. Additional names for other co-authors were developed. Two outlines have been developed, one of which is on the web page under the VA LTER site (www.vcrlter.virginia.edu). Data for the synthesis is being compiled and a bibliography is underway. A volunteer has been assisting in compiling data and conducting some preliminary analyses. A mid-December 1997 first draft is expected.

Behavior and Ecology of Birds with Emphasis on Tropical Areas

Mercedes S. Foster

The Alder Flycatcher (*Empidonax alnorum*) winters from Colombia and Venezuela, south to northern Argentina in riparian habitats along lowland meander rivers as well as in adjacent transition zone habitats in the flood plain. Dominant plant species in the riparian zone are all very fast-growing and suitable for commercial harvest for paper pulp. In addition, these areas of flood plain, where annual flooding leaves behind a rich silt deposit, are being considered for agricultural development, for the production of rice and soybeans. If such habitats are converted to commercial uses, the impact on the Alder Flycatcher could be significant. Baseline information on the biology of the Alder Flycatcher on its wintering grounds will be critical if a rapid response to a management need is required. We are studying the ecology of the Alder Flycatcher on the wintering grounds to determine how harvest of the vegetation might affect these birds. Birds are netted and color banded in riparian habitats on meander beaches along the Manu River in Peru. Territorial behavior and foraging ecology are being observed and territory size measured. Habitat use in different riparian zones is being monitored.

Migration Routes and Winter Ranges of Nearctic Migrant Birds

Mercedes S. Foster

Locality information contained in the bird collections of natural history museums in the form of specimen data are being entered into the Natural History Museum's computerized database, with efforts focused on families with large numbers of migrant species, in an effort to make these data easily accessible to investigators and managers. Where necessary, specimens are curated before the data are entered. Because locality data for many specimens do not include latitude and longitude and so cannot be used in a GIS application, we hope eventually to have sufficient funds to geocode these data by comparing our database with databases of geographic localities and merging geographic coordinate data where appropriate. This will allow us to generate maps of the migration routes and winter distributions of species of nearctic migrants, especially those species with suspected population declines.

Measuring and Monitoring Biological Diversity: Standard Methods

Mercedes S. Foster

Habitats worldwide are presently being degraded at a rapid rate. Thus, we need to gather as much information as possible about these habitats and their contained flora and fauna. To maximize comparability of data between sites, across habitats and taxa, and over time, the information must be collected in standard ways. We are developing or identifying standard methods for qualitative and quantitative sampling of biological diversity of various taxa and publishing handbooks detailing those methods.

**Development of Methods to Translate Water and Land Management
Practices into Physical, Hydrological, and Biological Changes
in the Riverine Corridor**

Mary C. Freeman

Collaborators: Elise R. Irwin, Alabama Cooperative Fish and Wildlife Research Unit

Resource managers lack well-validated, scientifically sound methods for evaluating potential impacts of habitat alteration on riverine communities, especially when dealing with species-rich communities characteristic of southeastern U. S. warmwater streams. The objectives of this project are to identify habitat features, including flow-mediated instream habitats, that may significantly influence populations and assemblages of native riverine fishes, and to develop interpretive assessment tools based on these results. Part of our focus is on effects of flow-regulation by hydro power facilities on fish assemblages in portions of the Tallapoosa River, AL. Our approach involves comparing fish densities and assemblage composition, based on annual sampling conducted in late summer, to habitat availability at flow-regulated and unregulated study sites. Habitat availability is estimated from hydrologic records and hydraulic models of instream habitat in relation to flow. Using data collected over four to five years, we will identify features of instream habitat, especially temporal patterns that are functions of flow regimes, that influence fish abundance and diversity. The results will have direct application in evaluating proposed flow regulation by water supply and hydropower projects or channel alteration. This research should significantly enhance our understanding of the processes by which natural flow variation and human-produced flow and habitat alteration influence fish assemblages. We are also investigating relationships between habitat features assessed at basin-level scales (e.g., fragmentation, hydrologic alteration, land-use) and biological integrity (emphasizing native fishes) in selected southeastern rivers. Results will aid basin-level management strategies by identifying watershed and hydrologic features that are correlated with instream biological integrity.

Tri-State Comprehensive Water Management Study: Riverine Habitat Component

Mary C. Freeman

Collaborators: John M. Nestler, U. S. Army Engineers Waterways Experiment Station

The states of Alabama, Florida and Georgia and the U. S. Army Corps of Engineers agreed to collaborate in a comprehensive study of water supplies and demands, and to evaluate management alternatives, in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint (ACT and ACF) river basins. The Environmental Scope of Work of the comprehensive study examined water quantity needs to support natural resources in the river basins, and the potential effects of alternative water management strategies on those resources. The Riverine Component, a cooperative effort involving the USGS-BRD, Army Corps of Engineers Waterways Experiment Station and U. S. Fish and Wildlife Service, assessed biological resource values in the two basins and habitat requirements for sustaining those resources. We developed habitat value models, intended to rank the relative effects of alternative water management scenarios on instream habitat quality, for 19 selected riverine sites in the basins. Developing the habitat-value functions involved fieldwork to quantify river channel characteristics at each study site and construction of hydraulic and habitat simulation models for each site. The habitat-value functions were initially referenced to monthly flows for unimpaired (“natural”) flow regimes, for use in monthly time-step basin wide simulation models. Work during FY98 will recalculate the value functions for use in management models using a daily time-step. Additional analyses will characterize the timing, magnitude, frequency and duration of hydrologic alteration in regulated river reaches in the basin and assess implications for riverine biota.

Completed

Information Transfer and Research to Address FWS-Region 4 Instream Flow Issues

Mary C. Freeman

Increasing demands for water resource development, e.g., construction of water supply reservoirs and interbasin diversions of water, represent potentially detrimental streamflow changes in the remaining free-flowing river segments of the southeastern United States. Additionally, relicensing procedures for existing hydropower projects represent an opportunity to improve operations relative to effects on aquatic species. When determining probable impacts of flow changes, U. S. Fish and Wildlife Service biologists often must recommend appropriate studies or review data already gathered with less than complete information on recent research findings, technological developments, or approaches used successfully in other cases. BRD ecologists involved in instream flow research can help facilitate thorough study planning and review by consulting, on request, with FWS personnel dealing with instream flow issues. Consultation with FWS biologists is also the most direct path for identifying research needs to support and improve instream flow methodologies. This task will address BRD's goal of facilitating sound management of biological resources by collaborating with partners.

Completed

Effects of Flow Regime on Recruitment and Growth of Juvenile Bass in Flow-Regulated Rivers

Mary C. Freeman

Collaborators: Elise Irwin, Alabama Cooperative Fish and Wildlife Research Unit
J. Jeffery Isely, South Carolina Cooperative Fish and Wildlife Research Unit

Riverine sport fisheries for black basses offer recreational opportunities accessible to boating, wading and streamside anglers across the United States. However, most large-river habitat exists under modified flow-regimes, and many segments experience extreme daily flow fluctuations downstream from peaking hydropower dams. Depressed fish abundances have been recorded in these systems. Year-class strength is generally set during early life history stages when vulnerability to disturbance regimes may impact recruitment processes. Understanding recruitment and growth processes in tailwater populations is key to predicting consequences of proposed flow management regimes in terms of potential for promoting populations of bass and other sport fishes. Specifically, data are needed that relate spawning success and juvenile growth to magnitude and stability of stream flow, in order to assess potential effectiveness of providing continuous minimum instream flow or periods of stable flow. Otolith daily growth rings will be used to establish swim-up date and growth rates of juvenile bass (*Micropterus punctulatus*, *M. salmoides* and *M. coosae*) from two tailwaters with contrasting flow patterns. Additionally, swim-up date and growth of juvenile bass collected from unregulated tributaries of the rivers will be quantified. Water temperature data continuously recorded at sample locations will be used to back-calculate spawn date from estimated date of larval swim-up. Using these data, we will test for correspondence of juvenile recruitment to periods of stable stream flow and relationships between juvenile growth rate and flow fluctuations.

Reproductive Performance and Associated Developmental and Endocrinological Effects of Polychlorinated Biphenyls (Aroclor 1242) on Captive American Kestrels (*Falco sparverius*)

John B. French Jr.

The endocrine function (as both hormonal mimics and antagonists) of many environmental contaminants has been emphasized recently, leading to the speculation that exposure to these chemicals during early development could lead to functional impairment later in life. Particularly important is the possibility that contaminants interfere with sex-steroid metabolism (estrogens have been most widely studied), since when hormone levels are altered during critical stages of embryonic and post-hatching development, the results can be abnormal maturation of the reproductive tract, abnormal endocrine function and poor reproductive capability as mature organisms. Certain PCB congeners have estrogenic activity; PCBs are highly lipophilic, mobilized with fat during reproduction, and body burdens in reproductive adults are transferred to offspring in the energy provisioned to the eggs. Using the breeding American kestrels at Patuxent as a model, this study tests the hypothesis that trans-generational exposure to PCBs can impair later reproductive performance of exposed offspring, and is associated with abnormal development of the reproductive system and endocrine function in exposed offspring. It meets Patuxent objectives in the areas of natural and human impacts on biological resources and will help develop indicators of the status of biological resources that are exposed to these compounds. Cooperators include Patuxent scientists Paula Henry, Barnett Rattner and Mark Melancon, and University of Maryland professor Dr. Mary Ann Ottinger. Results will include morphological, histological and endocrinological development of kestrel chicks exposed as embryos through PCBs deposited into the egg, as well as a functional test of the reproductive ability of similarly exposed kestrels.

Assessing Terrestrial PCB Contamination in the Eastern Region Using Shrews and Other Small Mammals

John B. French Jr., Mark J. Melancon

The overall goal for the study is to assess biotic harm from PCB contamination in a terrestrial habitat, and the strategy is to focus on indicator organisms that are likely to have relatively high exposure in polluted terrestrial habitats. The project will focus on shrews because they feed at a high trophic-level hence exposure to PCBs is likely to be high, and thus effects are likely to be seen most easily in this species. Field investigations consist of comparing the communities of trappable small mammals (including three shrew species) found on study plots within a highly polluted area, to the mammals found at a reference plot nearby. For the more abundant species, population parameters from mark and recapture data will be compared between the sites. The polluted site is an area surrounding the pump station on a petroleum pipeline in Pennsylvania, which has regularly released PCBs in the past. Data on general levels of soil contamination has been obtained from the Pennsylvania Department of Environmental Protection. A laboratory portion of the study will develop a method to measure P450 induction in live short-tailed shrews (*Blarina brevicauda*) by the measuring the amount of sleep induced by a standardized dose of pentobarbital. By using this *in vivo* technique in our field study, we hope to gather data on exposure without killing the animals, and reduce the interference with population and community level investigations. Collaborators include: Dr Gordon Kirkland of the Vertebrate Museum at Shippensburg University, Shippensburg, PA; Dr. Richard Halbrook and Julie Russel, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL. The Pennsylvania Game Commission invited us to submit proposals to them for this work; it meets their needs for better information on PCB pollution in the future.

Effect of PCB Exposure on Energy Balance of Small Mammals

John B. French Jr., Mary Beth Voltura, Post-doctoral associate

The objective of this study is to explore the mechanisms by which PCBs exert sub-lethal effects on small mammals, in the context of whole-animal energetics. This study is part of a larger project underway assessing the effect of PCB contamination using small mammals. It is difficult, however, to evaluate the effects of sub-lethal doses of contaminants on animal fitness in the field. Energy budgets have been used successfully by ecologists to link environmental variables (e.g. food supply or thermal environment) to individual performance (e.g. growth, reproductive output). By establishing linkages between PCB exposure and ecologically relevant measures such as energy balance, survival and reproduction, the information from this study will enable researchers to evaluate the consequences of PCB contamination for small mammal populations. The focus will be on three species, chosen because they are the common and tractable species found at the field site in Pennsylvania: short-tailed shrews (*Blarina brevicauda*), white-footed mice (*Peromyscus leucopus*) and red-backed voles (*Clethrionomys gapperi*). We will investigate the effect of PCBs on metabolic rate, food intake, and body mass dynamics in controlled laboratory experiments. Captive breeding will determine the consequences of PCB ingestion for a variety of reproductive parameters, including litter size, offspring survival, lactation energetics, and mass and growth rate of young. We are collaborating with Dr. Olav Oftedahl, a nutritionist with the National Zoo (Smithsonian) for analysis of the rate and energetic content of the milk produced by breeding females.

Control and Containment of the Brown Tree Snake

Thomas H. Fritts, Gordon H. Rodda

The U.S. Geological Survey's Brown Tree Snake Research Program has a central role in the study of the biology of the brown tree snake, control alternatives for use on Guam, the ecology of Guam and other Pacific Islands, and ecosystem changes due to introduced species and habitat alterations occurring in the region. This work uses funding provided by partners in Interior's Insular Affairs and Fish and Wildlife Service for which research results are critical in guiding and facilitating management activities and in determining the magnitude of the problem, planning future programs and direct intervention to reduce risks to other ecosystems. Controlling populations, limiting dispersal, eradicating new populations, and monitoring changes before losses occur are all real needs of various federal and local agencies. The Brown Tree Snake has been present on Guam for about 40 years, but has been well documented on islands in the Northern Marianas only in recent years. Comparative studies on these islands are needed to better understand continuing ecological changes, guide management actions to preserve components of the insular ecosystems, and address ways to slow, contain, or eliminate future invasions and restore ecosystems to the degree possible. The continued spread of the snake (recently to the Northern Mariana Islands), and real threat of dispersal to the State of Hawaii justify real time measurement of ecological changes, determining rates and magnitude of perturbations, interactions with other exotic species, environmental alterations due to humans, and better documentation of the complexity of changes throughout the insular ecosystem, instead of just focusing on operational actions that are at inappropriate scales to prevent further ecological degradation of island ecosystems. Primary emphases in FY-98 include further development of temporary and permanent barriers needed for protection of ecological habitats and transportation situations and continued work on trapping, sensory attractants, movements, and other biological factors essential to understanding the snake in situations where it is well established as well as in new founder populations. Special emphasis will be placed on identifying population stress factors, studies of reproduction and juvenile snake biology, and means of controlling snakes in low density (founding) populations. Simultaneously work will focus on determining baseline ecological information and monitoring ecological changes in vertebrate, invertebrate and plant taxa as possible. The nature of this work demands a high level of technical assistance, interagency coordination, and reporting in addition to use of normal outlets for research products.

Systematics of American Mammals

Alfred L. Gardner

The Mammal Project conducts museum specimen-based research and has responsibilities for the care, management, and documentation of the North American National Collection of Mammals and the National Type Collection of Mammals deposited in the National Museum of Natural History. Current research includes revisions of the systematics of fur seals; review of Mexican and Guatemalan brocket deer; revisions of Latin American bats, marsupials, and oryzomyine rodents; revision of the Checklist of Vertebrates of the United States, the U.S. Territories, and Canada; and a collaborative review of the taxonomy, distribution, and ecology of South American mammals that includes gazetteers, taxonomic synonymies, mapped distributions, and identification keys.

The Mammal Project provides mammal-related and collection management information and expertise to Department of the Interior (DOI) bureaus, the Smithsonian Institution, and other Federal, State, and local government agencies; national and international governmental, academic, and private institutions; and the general public. These services include identifications of mammals and their parts (teeth, skins, hair, bones); information on taxonomy, nomenclature, distributions, ecology, natural history, and collection records; and training in museum, laboratory, and field techniques and methods.

Restoration Ecology of a Non-Migrating Population of Whooping Cranes in Florida: Behavioral and Habitat Changes to Increase Survival

George F. Gee, David H. Ellis, Glenn Olsen, Jane M. Nicolich,
Kathleen E. O'Malley, Jonathan Male

The successful production of captive-bred cranes is an essential part of the conservation and reintroduction plans for the whooping crane and other endangered/ threatened crane species. Productivity and access to the wild population in the Wood Buffalo National Park are limited. Parks Canada wants to end egg collection from Wood Buffalo National Park after 1996. The whooping crane recovery team has begun a project to establish a nonmigratory population of whooping cranes in Florida. Because of these and other reasons, captive produced stock is necessary to provide for the reintroduction efforts.

The Florida reintroduction effort started in 1993. We have released 128 birds. Of these 65 survived in the summer of 1997 and only 14 of these are birds released before the winter 95/96. Most (49) whooping crane losses in the Florida release project resulted from predation by bobcats. Some losses may have been the result of other events and bobcats simply took advantage of a weak bird. We need methods to control bobcat predation, especially during the first few weeks post release. In 1996 and again this year, we improved rearing and conditioning of birds for release. Also, we made a significant improvement in release technique. We moved the release site to a more open habitat (bobcats prefer bushy and woody cover) in the winter 95/96. This July 20 of the 28 birds released last winter survive.

Restoration Ecology of Mississippi Sandhill Cranes (Through Release and Changes in Water Control and Vegetation Management: Reproductive Success)

George F. Gee, David H. Ellis, Glenn Olsen, Jane M. Nicolich, Kathleen E. O'Malley
Jonathan Male, Mark J. Melancon

The US Fish and Wildlife Service first noticed the decline in the Mississippi sandhill crane population in the early 1960s. The Service began captive breeding at the Patuxent Wildlife Research Center in 1965 to protect the subspecies during habitat restoration and to provide stock for reintroduction. The Service added the Mississippi sandhill crane to the Endangered Species List in 1973 and established the Mississippi Sandhill Crane National Wildlife Refuge in 1974. The Mississippi sandhill crane served as a research surrogate for the whooping crane.

In the early 1980's, re-introductions failed in Mississippi because the bird's reluctance to associate with wild conspecifics. Only recently have hand-reared birds proven suitable for release. For four years (1989-1992) we released Mississippi sandhill cranes in three experimental groups and collected survival data. In January 1993 the release population exceeded 115 birds. Hand-reared Mississippi sandhill cranes may have imprinting problems that interfere with reproduction. We need to know if the costumed-reared release birds pair and reproduce like the parent-reared birds. This year we had 19 breeding pairs in Mississippi, all of which contained one or more release birds. This is the second consecutive year when we recorded more than six nesting pairs in Mississippi. A P450 biological monitoring study of liver biopsies from wild-caught Mississippi sandhill cranes began this summer.

Development of Methods for the Restoration Ecology of Cranes

George F. Gee, David H. Ellis, Glenn Olsen, Jane M. Nicolich,
Kathleen E. O'Malley Jonathan Male

We need to improve our manipulation of behavior, physiology and disease to successfully restore crane populations. An understanding of the crane's circannual hormone rhythms as they relate to reproductive behavior, photoperiod, and stress will offer valuable information. Recent development of fecal steroid enzyme immunoassays (Lasley and Kirkpatrick 1991, Lee et al. 1995) allow us to make noninvasive serial examinations of hormone cycles in groups of reproductively successful cranes. Analysis of the samples from captive Florida sandhill cranes and from whooping cranes on the Aransas National Wildlife Refuge for corticosterones, estrogens, and androgens is underway.

We believe differences in hatchability between artificially and naturally incubated eggs result from differences in heat distribution. The bird establishes a temperature gradient inside the egg and mechanical incubators provide a uniform warmth. Crane egg hatchability continues to improve using a combination of parental and incubator incubation. Hatchability of fertile whooping crane eggs in 1997 exceeded 94% in 1997.

Natural fertility in many captive cranes is poor. Our goal is to encourage natural copulation in breeding whooping cranes through proper imprinting of the young cranes, and through building facilities that enable us to keep fully-winged birds. We have six naturally fertile whooping crane pairs and eight more that should start production in the next few years.

Because of possible food poisoning problems, we bioassay all crane feed before feeding it to the cranes. The monitoring began in 1987 after a mycotoxin poisoning occurred in the Patuxent cranes. Although no recent feeds have been contaminated, we have rejected one batch of feed since the monitoring began.

In cranes, coccidia parasites cause disease both in the intestinal tract and in a disseminated visceral form (DVC). Patuxent uses coccidiostatic drugs to control DVC. We started a three-year vaccine study two years ago. We are now analyzing the data from very successful work with the masked bobwhite. We now know that *Eimeria reichenowi* is highly pathogenic to cranes. This information was used last summer to help control an epizootic in a research crane flock in Idaho. We will continue to work with the cranes to test the vaccine's potential for protecting these birds.

Isolation and Evaluation of Entomopathogenic Fungi Associated with Deer Ticks (*Ixodes scapularis*)

Howard Ginsberg

This project is designed to carry out extensive screening of wild-caught ticks for fungi that show potential as biological control agents, and to perform pathogenicity trials in the lab. Screening will take place in New York (Fire Island National Seashore) and southern New England. Laboratory trials will be designed to determine the potential efficacy of each strain of fungus (and possibly other tick pathogens) for biological control and to establish the conditions under which the most promising strains are likely to be most effective.

Neotropical Migratory Birds and the Impact of Brood Parasitism

D. Caldwell Hahn

This study investigates the effects of an invasive avian species on an eastern forest community of high biodiversity. Brood parasitism by the native brood parasite, Brown headed Cowbird, reduces the viability of native wildlife, with some effects more significant than others. We are using a novel approach of integrating molecular genetics analyses with geospatial mapping to illuminate the patterns of parasitism in a northeastern forest. The results will be applied to management recommendations for detecting when cowbird parasitism is a threat to local birds and for controlling cowbird populations that are causing damage.

Managing Coastal Wetlands for Increased Biological Diversity and Carrying Capacity

D. Caldwell Hahn

This collaborative project between USGS\BRD\PWRC and South Carolina Department of Natural Resources (SCDNR) investigates integrated management strategies for coastal impoundments. The objective is to develop modifications for traditional waterfowl management regimes that better support wading birds and thus increased biodiversity. The ACE Basin is an outstanding wetlands resource of 28,500 ha, constituting 60% of the total impounded wetlands on the Atlantic Coast, and managed by a combination of state, federal, and private owners. Several large wading bird colonies including endangered Wood Stork and declining White Ibis breed there. We propose to build on the long term waterfowl management plans of these extensive impoundments with systematic examination of different drawdown schedules. The study will establish baseline descriptive use of coastal waterfowl impoundments by wading birds and will use video cameras to film birds' use of impoundments. We will also measure habitat characteristics such as salinity, dissolved oxygen, ambient temperature, water level, and fish density. The study will also analyze fish for mercury to compare the effects of drawdown and reflooding in coastal brackish impoundments with the increase found in freshwater Canadian impoundments. The results of the study will be used to produce and disseminate an integrated waterbird private landowners.

Co-editorship of Studies in Avian Biology Volume

D. Caldwell Hahn

This study investigates the effects of an invasive avian species on an eastern forest community of high biological diversity. Brood parasitism by the native brood parasite, Brown headed Cowbird, reduces the viability of native wildlife, with some effects more significant than others. We are using a novel approach of integrating molecular genetics analyses with geo-spatial mapping to illuminate the patterns of parasitism in a northeastern forest. The results will be applied to management recommendations for detecting when cowbird parasitism is a threat to local birds and for controlling cowbird populations that are causing damage.

Anacostia Wetland Studies

Richard S. Hammerschlag

The reconstruction of Kenilworth Marsh in 1993 justified the establishment of a multi-agency monitoring team committed to a five year monitoring program. The National Park Service with direct support from the National Biological Service accepted the responsibility of conducting the water quality metrics, the wetland vegetation monitoring and wildlife inventories. The first three years of these studies have been completed (1993-1995) with an annual report compiling all the agency studies for 1993, 1994 and 1995. The work plan is designed to complete the last two years of studies (1996 and 1997) of the five year program. It will involve a continuance of bi-weekly water sampling of the Anacostia (13 sites) and Kenilworth Marsh (7 sites) systems from April thru November measuring at least 14 parameters including nitrogen and phosphorus forms. The vegetation monitoring consists of a system of 25 (35 meters in length and subdivided into 7 five meter sectors) transects, including three controls, conducted throughout Kenilworth Marsh repeated once monthly from May to October. This effort is expected to reflect the pattern of wetland vegetation establishment over the five year period and during each growing season. For the wildlife component the NBS is supporting a contracted herptile study and mammal study by Dr. Chris Athanos and Assoc. Thus this work plan will support a broad array of studies conducted in direct partnership with the NPS as part of a multi-agency commitment to the Anacostia. Results from these studies are being directed to the Corps of Engineers and Pepco in support of their efforts for additional wetland reconstruction along the Anacostia.

Development and Evaluation of Strategies for Managing Invasive Non-Native Plants in Rock Creek Park

Richard S. Hammerschlag

The National Park Service in collaboration with the Biological Resource Division of the USGS through this project will develop, test and document a treatment strategy for control of invasive non-native plants (INP), in this case the vines *Ampelopsis brevipedunculata* (porcelain berry) and *Celastrus orbiculatus* (asiatic bittersweet) in Rock Creek Park, Washington, D.C. Such invasive, non-native species are recognized as the most serious threat to the integrity of natural systems as they can spread rapidly and interfere with, dominate or replace native taxa and plant assemblages. Nearly 33% of all plant species in Rock Creek Park are non-native. The most extensive and intensive patches of these INPs will be located, mapped and plotted using GPS and GIS technologies. The configuration and relative density of the vines in each selected patch will be defined and measured. Control and treatment test plots for chemical application using Garlon 3A will be located in several vine patches for each species. To the extent practical entire patches will be treated by cutting vines and then treating re-sprouts with Garlon. The located plots will be monitored for at least three years following treatment. As a result extensive information transfer is planned to pass along methodologies to other park units and interested parties.

Completed

Herptile and Small Mammal Surveys for National Capital Area-East

Dick Hammerschlag

Collaborator: Steve Syphax, National Capital Area-East, NPS

The herptile and small mammal populations of National Capital Parks-East are virtually undocumented in any systematic fashion. These preliminary studies are designed to inventory the herptile and small mammal populations of three sites: Kenilworth Park, Kingman Lake and Oxon Cove. Species lists, habitat characterizations and maps, as well as some abundance estimates will be produced. Methodologies include a combination of visual encounter surveys along a series of transects, targeted sampling by both time and place as well as utilization of a system of drift fence arrays involving pitfall traps and funnels. Traps will be monitored daily. Sampling will be focused during the primary activity periods of the spring and early fall months. As a result of the study efforts a determination of species diversity (richness), population estimates and important habitat areas will be made.

Case Studies for Controlling Exotic Plants in the East: a workshop

Richard S. Hammerschlag

The process of controlling unwanted invasive weeds requires documentation so others may benefit from the degrees of success and failure from deliberate studies. The proposed workshop will be keyed upon case studies often dealing with the management of single species. There will be a field trip to at least Rock Creek Park to interact with sites that have undergone a treatment regimen as well as control areas; also included will be several of the established monitoring plots. The workshop anticipates co-sponsorship by the USFS and FWS. The workshop will seek an audience comprised not only of resource managers, and land managers but also policy makers and program people. It will be held at the Patuxent Wildlife Visitor Center on September 16 and 17, 1998.

Technical Assistance to National Capital Region, National Park Service - Urban Landscape Ecology

Richard S. Hammerschlag

The incumbent has had over 25 years of working with or in close cooperation with the National Capital Region of the National Park Service. This task provides a basis for continuance of technical assistance and consultations (almost ongoing conversations) along the same lines that have occurred in the past. Input could be expected along the broad topics such as landscape management (urban ecology, wetlands, site planning, arboriculture, hazardous trees, site restoration, exotic species etc.), aquatic system management (ornamental pools, submersed aquatic plant control, water quality, vernal pools etc.), non-point source runoff control (stream quality and habitat, etc.), and general science needs.

Development of Patuxent long-term Monitoring and Ecological Research Project (PALMER)

Richard S. Hammerschlag

Long term monitoring of biological resources is at the core of understanding the dynamics of ecological patterns and processes and trying to separate out variation due to natural vs. anthropogenic influences. On public lands especially, questions often arise concerning the potential impacts on natural resources of activities such as recreation, grazing, timbering, agricultural practices, etc. On land units such as refuges, parks, and national forests, biologists and managers need to properly evaluate their past and current biological monitoring activities, archive it electronically, and further, determine additional monitoring needs. Working with researchers, resource managers need to identify monitoring projects that could be included in an Adaptive Resource Management context. For example, by monitoring different impoundment drawdown schedules that are replicated on a refuge, biologists can learn how to optimize plant growth for use by migratory birds. Within this context, a project was initiated in 1996 at the Patuxent Research Refuge known as PALMER, the Patuxent Longterm Monitoring and Ecological Research project. The first step was to compile and update a bibliography of studies of the Refuge dating back to the early 1900s. Major data sets were identified, classified, and being prioritized for electronic entry. Some of the data sets are more than 45 years old (eg. Forest birds and box turtles). Second, the grid system on the Refuge has been improved and included in a GIS. Further, a GIS is under development including refuge boundaries, building and road features, impoundments, meadows, as well as biological observations such as breeding and wintering bird plot data, small mammal trapping grids, turtle locations, odonate ponds, and forest monitoring plots. Long term trends of birds, turtles, and forest changes have either been published or are being planned. Some of the products of these efforts are available on the Patuxent homepage at: <http://www.pwrc.nbs.gov>.

Breeding Ecology of the American Black Duck (*Anas rubripes*) in the Bloodworth-South Marsh-Deal Island Complex

G. Michael Haramis, Dennis G. Jorde

Investigative study of the breeding ecology of island nesting American black ducks (*Anas rubripes*) in the mid Chesapeake Bay has resulted from an initiative by Department of Defense-Navy to include its 5,400 acre Bloodworth Island Shore and Bombardment Range under cooperative management by the North American Waterfowl Management Plan. The islands of Bloodworth, South Marsh and Smith remain some of the most valuable wild marsh and insular wildlife habitats in the Chesapeake Bay, and are one of the remaining strongholds for breeding black ducks in the region. Because of live ordinance and lack of logistic support on Bloodworth Island, comparative studies were conducted primarily at the 4,400 acre Martin National Wildlife Refuge on Smith Island. During 1995 and 1996, telemetry methods were used to track female black ducks, document their survival, reproductive performance and habitat use. During 1996, a pilot telemetry study investigating movements of red foxes (*Vulpes vulpes*) was initiated and GIS mapping of the islands was completed through support of the Navy and the University of Maryland. In addition, a 12-year summary of local and regional black duck and mallard (*Anas platyrhynchos*) bandings and recoveries was completed. Field work with black ducks terminated in 1996 and red fox work will finish in 1997. Management reports and scientific publications will be prepared in 1997.

The Effect of Nutria (*Myocastor coypus*) on Marsh Loss in the Lower Eastern Shore of Maryland: an Exclosure Study

G. Michael Haramis

Introduced in the 1940's to bolster Maryland's Eastern Shore fur industry, the herbivorous South American nutria (*Myocastor coypus*) has become overpopulated and implicated as a catalyst to marsh loss along the tidal, emergent marsh habitats of the Blackwater River in Dorchester County. The alarming loss of marsh, especially of Olney 3-square (*Scirpus olneyi*) marsh, has prompted state legislation proposing a 10-year nutria eradication program. This program was outlined following recommendations from British researcher L.M. Gosling who conducted a similar nutria eradication program in England and was contracted to evaluate the nutria situation in Maryland. Because the relationship between nutria foraging activity and marsh loss remained undocumented, MD-DNR postponed adoption of a long-term eradication effort until more convincing evidence of cause and effect could be obtained. To this end, a collaborative research partnership was formed between the State of Maryland, the Blackwater National Wildlife Refuge, and the Patuxent Wildlife Research Center to investigate the role of nutria in marsh loss. Following recommendations of L.M. Gosling, a study adopting exclosures was proposed.

Length of Stay, Survival, and Habitat Use of Fall Migrant Sora (*Porzana carolina*) on the Patuxent River Marsh as Determined by Radio Telemetry

G. Michael Haramis

Collaborators: Gregory D. Kearns, Maryland National-Capital Park and Planning Commission

This research project investigates the ecology and status of the sora rail (*Porzana carolina*) at a critical and historic migratory stopover habitat of the wildrice marshes bordering the tidal Patuxent River, a major tributary of the Chesapeake Bay. So abundant were fall migrant soras in this marsh in the past that a unique sport hunting culture developed between the 1890s and the 1950s. It is estimated that at the height of this hunting era, 20-35 thousand soras were harvested here annually in September and October. Today, both the wild rice and the soras have declined and virtually no information is available to manage the sora, or its migratory stopover habitats, especially the declining wildrice marshes. The project is sanctioned by the State of Maryland Department of Natural Resources and the study area is part of the NOAA's National Estuarine Research Reserve. Additional funding has come from a variety of private sources including Quail Unlimited, Prince Georges Community College, and the Maryland Ornithological Society; other grants are pending. The project was recipient of a Fish and Wildlife Service Region 5 Challenge Grant in 1997. One field season of the study has been completed and successful techniques to capture and radio mark soras have been developed. Primary data collection is based on large sample trap captures and radio tracking soras on the study area and during migration down the Atlantic coast.

Growth and Survival of Trees in a Hawaiian Montane Rain Forest

Jeff S. Hatfield

The Hawaiian montane rain forest is one of the most uncommon and threatened tropical forests in the world. The Kulani Forest on Mauna Loa and Hakalau Forest National Wildlife Refuge on Mauna Kea, both on the island of Hawaii, provide breeding habitat for six species of Hawaiian honeycreeper finches (three of which are endangered) and several other species of rare and endemic forest birds. A previous study (Biotropica 28(4b):746-758) estimated the density of trees and shrubs on 68 0.04-hectare study plots at Kulani and concluded that the two canopy species, ohia (*Metrosideros polymorpha*) and koa (*Acacia koa*), are able to coexist in this primary rain forest at 1500-1850 m elevation probably because of year-to-year variability in recruitment and differences in seed dispersal into large gaps. However, that analysis was based on a mathematical model and it was assumed that koa grew at a faster rate than ohia. Growth studies in the literature support this assumption but it has not been verified in a forest on both species simultaneously. In the present study, 1070 individuals of the two canopy species, eight common subcanopy species, and several rare species of trees and shrubs have been marked at Kulani with aluminum tags and are being monitored for three years to compare growth and survival. At Hakalau, 100 individuals of ohia and koa also have been tagged and are being monitored. Hopefully, these data eventually will be used in a forest simulation model to evaluate management options for restoration of degraded tropical forests in Hawaii, but development of that model would be proposed later as a new study.

Completed

Investigating the Use of Tetracycline to Batch-Mark Juvenile Frogs and Toads

Jeff S. Hatfield, Paula Henry, Glenn Olsen, Mary Paul, Richard Hammerschlag

A population viability analysis of the endangered Houston toad (*Bufo houstonensis*) has suggested that first year survival is an important parameter to estimate. Unfortunately, juvenile amphibians are often difficult to tag for mark/recapture studies and therefore this survival rate generally cannot be estimated for amphibians. The small size of many juvenile amphibians, plus the regeneration of toes in some species, does not allow for toe-clipping and other tagging methods to be used. Tetracycline, however, is commonly used to batch-mark larval fishes for mark/recapture and growth studies. At the proper concentration, immersion in a solution of tetracycline does not increase mortality and the tetracycline is deposited in bone tissue. When viewed under UV light, this bone has a fluorescent golden-yellow band. We are testing this method of batch-marking on metamorphosing pickerel frogs (*Rana palustris*, n=6) and green frogs (*Rana clamitans*, n=50) by immersion of individuals in two concentrations of tetracycline (250, 500 mg/l) or control (0 mg/l) for a 24 hour treatment period. These individuals will be kept for a year and one toe will be clipped from each individual at 2 weeks, 4 weeks, 12 weeks, 24 weeks, 36 weeks, and 48 weeks after the beginning of treatment to take a sample of bone to test for fluorescence. If this method is successful and the mark is visible, it will be tested on metamorphosing toads (*Bufo* spp.) collected at Patuxent in the spring or early summer of 1997.

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Toxicity of Lead-Contaminated Sediments to Waterfowl

Gary H. Heinz, David J. Hoffman

This study is being conducted in response to a U.S. Fish and Wildlife Service Natural Resource Damage Assessment case. The methods and results are litigation sensitive.

Toxicity of Biologically Incorporated Contaminants

Gary H. Heinz, David J. Hoffman

Laboratory studies will remain a mainstay for understanding the harmful effects of environmental contaminants on wildlife, but the ability to extrapolate from laboratory findings to the field can be greatly enhanced by exposing laboratory animals to contaminants in ways that simulate natural exposure in the wild. One aspect of natural exposure is that contaminants generally are biologically incorporated into foods in contrast to the chemically pure forms often used in lab experiments. A second condition often encountered in nature is the co-occurrence of more than one contaminant in the diet at the same time, and a third problem that wildlife often face is the simultaneous exposure to a toxic chemical plus a non-contaminant stressor such as bad weather, poor nutrition, disease, or migratory and breeding demands. Resource managers need realistic predictions of what contaminants will do to wildlife under the complex mixture of stresses to which wildlife are exposed. Experimental approaches will involve combinations of contaminants or contaminants plus non-contaminant stresses. Measurements will center on effects such as survival and reproductive success because these are the effects of most immediate concern to resource managers. Findings will be expressed in terms of how much of a contaminant in combination with other contaminants or non-contaminant stresses causes harm. Residues of contaminants in tissues will be related to degree of harm because these residues are generally what a resource manager has knowledge of with a wild population.

Endocrine Disrupting Chemical Effect on a Potential Reptilian Model

Paula F. P. Henry

Activation of sexual maturation and the resulting reproductive success in an animal are very closely dependent on the initial organization of the neural and endocrine circuitry established during development of the embryo and early life stages. Because many of the endocrine disrupting chemicals (EDCs) of concern "mimic" circulating hormones, it is difficult to distinguish between effects on embryonic development due to the gonadally synthesized natural hormones and their feedback mechanisms, from effects due to the added exogenous EDCs. The diamondback terrapin (*Malaclemys terrapin*) exhibits temperature-dependent sex determination (TSD). Because of the plasticity of its gonadal development, the turtle is a good model for investigating mechanisms of action and effects on sexual differentiation of gonads, as well as other potentially sexually dimorphic systems. A series of PCBs were topically applied to terrapin eggs at different stages of development to screen for sensitivity of the terrapin to select EDCs, based on timing of exposure, degree of hydroxylation, and chemical structure. With the use of positive control groups, a series of anatomical, physiological and neuroendocrine measures are being screened to evaluate effectiveness of endpoints and potential correlations to exposure. Work is being conducted in collaboration with Dr. M. A. Ottinger of the Avian and Animal Sciences Department at the University of Maryland, College Park.

Exposure to a Persistent Estrogenic Contaminant During Embryonic Development and its Long Term Effect on Adult Sexual Differentiation - A Field Investigation

Paula F. P. Henry

Ho: *In ovo* exposure to an estrogenic/antiandrogenic chemical alters sexual differentiation during embryonic development and expression of sexual dimorphic characteristics during maturation..

At least 3 events must be completed successfully during the development of a wildlife organism in order for that animal to succeed as a sexually mature adult: differentiation of gonads and duct systems, organization of CNS and associated neuroendocrine structures, and proper activation and integration of these systems during sexual maturation. This study will investigate endocrine disrupting effects from early embryonic development when gonadal and neuroendocrine signals are organized, through sexual maturation when effective behavior associated with inter and intra specific relationships and reproductive success are very dependent on appropriate activation of the neural and endocrine systems. Initial toxicity trials will be conducted on Japanese quail (*Coturnix coturnix japonica*), an avian model known to incorporate endocrine disrupting chemicals (EDCs) in the egg and which sexually matures in a few weeks. Measurements of exposure (vitellogenin or enzyme induction) and of effects (neurotransmitters/plasma steroid, gonadal morphology and mating behavior) will be collected and statistically analyzed from tissues collected over 3 generations of chemically challenged quail. Developmental and sexual behavior during maturation and associated neural and endocrine endpoints under endogenous hormones control have been well characterized in the quail, making it an appropriate model for screening effects of exogenous estrogenic chemicals. Based on findings obtained from the trials on the quail, a controlled, 3 year field study incorporating embryonic development, subadult and adult sexual activation and maturation is planned with the red-winged blackbird (*Angelaius phoeniceus*). Information obtained from this multi year and field approach should complement findings from egg injection studies and investigations currently being conducted at PWRC on reproductive performance of PCB exposed birds.

Work is being conducted in collaboration with Dr. M.A. Ottinger of the Avian and Animal Sciences Department of the University of Maryland, College Park.

Investigating the use of Tetracycline to batch mark Juvenile Frogs and Toads

Paula F. P. Henry

A population viability analysis of the endangered Houston toad (*Bufo houstonensis*) has suggested that first year survival is an important parameter to estimate. Unfortunately, juvenile amphibians are often difficult to tag for mark/recapture studies and therefore this survival rate generally cannot be estimated for amphibians. The small size of many juvenile amphibians, plus the regeneration of toes in some species, does not allow for toe-clipping and other tagging methods to be used. Tetracycline, however, is commonly used to batch-mark larval fishes for mark/recapture and growth studies. At the proper concentration, immersion in a solution of tetracycline does not increase mortality and the tetracycline is deposited in bone tissue. When viewed under UV light, this bone has a fluorescent golden-yellow band. We are testing this method of batch-marking on metamorphosing pickerel frogs (*Rana palustris*, n=6) and green frogs (*Rana clamitans*, n=30) by immersion of individuals in two concentrations of tetracycline (250, 500 mg/l) or control (0 mg/l) for a 24 hour treatment period. These individuals were kept for 12 weeks and, while under anesthesia, one toe was clipped after 2 weeks and one toe was clipped at 12 weeks to take a sample of bone to test for fluorescence. The treated frogs had a higher survival rate than controls and all surviving frogs were released back into the wild at the end of the study. If this method is successful and the mark is visible, it will be tested on metamorphosing toads (*Bufo* spp.) collected at Patuxent in the spring or early summer of 1998.

Endocrine Disrupting Chemical (EDC) Effects in Precocial and Altricial Avian Models on Embryonic Organization and Sexual Maturation

Paula F. P. Henry

Several documents and governmental efforts have called upon the need to develop and validate “quick” screening tests for evaluating hazard and risk of chemical classes and mechanisms of endocrine action (e.g., at the receptor binding levels or gene activation; estrogenic, antiandrogenic, androgenic, or antiestrogenic properties), and for evaluating long term and population effects on wildlife resources: EPA/630/R-96/012: Special Reports on Environmental Endocrine Disruption: An effects assessment and analysis, February 1997; USGS BRD Research Strategy for Endocrine Disruptors, December 4, 1997; Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), February 3, 1998. The proposed effort is one of 3 projects being proposed by USGS-PWRC under the FY97 \$1M Congressional support to BRD for EDC studies. Potential chemical selection, endpoints, and hormone methods will be integrated with projects conducted by Drs. J. French and D. Sparling.

Given the numbers of chemicals which are present or are being released into the environment, as well as the flow of chemicals coming up for registration, rapid screening assays are essential. However, in wildlife research and resource management programs additional information which is not known and continues to be requested are: how permanent is the effect on an individual, and how important is the real effect on a population. To address these questions, one needs to study exposure and effect endpoints at critical stages of life cycles and track measurements throughout the cycle, as well as effects over time (multigenerational); endpoints need to include a wide range of the individual’s physiological response in order to evaluate effects on the whole organism, and what the consequences of some of the effects are in terms of potential reproductive success of that individual and its offspring success, and in terms of how it survives in the field. This project proposes to investigate potential EDC effects on precocial and altricial avian models at 3 levels: during late embryonic (precocial) or post hatch (altricial) when both gonadal development and brain organization are “set”; at the onset of sexual maturation when effective behaviors associated with mating are very dependent on activation of the neural and endocrine systems; and in the F1 offspring for delayed effects due to carry over or “repeated” exposures. The two major axes to be investigated include the sensitivity of the aromatase activity along the hypothalamic-pituitary-gonadal (HPG) axes, and thyroid hormones along the hypothalamic-pituitary-thyroidal (HPTh) axes.

Ho: *In ovo* exposure to an EDC alters sexual differentiation and growth during embryonic development, and subsequent expression of sexual dimorphic characteristics during maturation. There are 2 distinct studies to this project, each study designed to specifically test each part of the overall hypothesis. The objective of study 1 is to obtain potential morphological and neuro endocrine measures of EDC effects in a precocial avian model during critical life stages in development. Study 2 will define measures of potentially EDCs-induced parameters in sexual differentiation and maturation of an altricial (passerine) species, and overall effect on reproductive success in the field. These efforts should generate reports and refereed publications on EDC effects on aromatase and thyroid systems in 2 different avian models, validate an aromatase assay for indicating EDC effect on target tissues, and evaluate the potential for EDC effects on expression of secondary sexual characteristics and reproductive strategies in a passerine model. This work is being proposed in collaboration with investigators at the University of Maryland, College Park.

Toxicity of Lead-Contaminated Sediments to Juvenile Waterfowl, Including Estimation of Sediment Consumption by Waterfowl

David J. Hoffman, Gary H. Heinz, W. Nelson Beyer

As the result of many decades of mining and smelting along the Coeur d'Alene River in Idaho, waterfowl have been dying from lead poisoning since the early 1900s. This study is part of a Natural Resources Damage Assessment (NRDA) for the Department of Interior, designed to evaluate the effects of sediment ingestion on growth, survival, and potential biological indicators of exposure in pertinent species of juvenile waterfowl (mallards and goslings). The objectives of this study are to (1) determine whether ingestion of Coeur d'Alene River sediments is harmful to juvenile waterfowl (mallard ducklings and goslings), (2) estimate the consumption of sediment by waterfowl on the Coeur d'Alene River and their exposure to lead, and (3) relate the above to field exposures of waterfowl in the Coeur d'Alene area to better interpret field data at given residue levels for lead and needs for appropriate restoration. These findings will help to enhance scientific understanding of the natural and human-induced processes that influence the structure and function of biological systems as related to lead and other metals in river and lake sediments. Collaborative partners include the FWS, other divisions of GS, the state of Idaho and the University of Maryland (academia). New end points for biological monitoring and helping to assess the status and trends of biological resources to the Department of the Interior will be published and presented at symposia. Ultimately these findings and future monitoring will be used to evaluate restoration strategies and techniques for degraded ecosystems including this location.

Comparative Embryotoxicity of PCB Congeners by Egg Injection

David J. Hoffman, Mark J. Melancon

Polychlorinated biphenyls (PCBs) are persistent and lipophilic environmental contaminants that are ubiquitous throughout the global ecosystem. The most acutely toxic PCB congeners are environmental stressors since they assume coplanar conformations similar to dioxin. Bald eagles and terns are vulnerable as revealed by reproductive data in the Great Lakes and in New England. The utility of egg injection studies for predicting potential embryotoxicity of this class of compounds (PCBs and TCDD) compares favorably with feeding studies. Study objectives are: (1) to examine the effects of coplanar and other PCB congeners on embryonic development through hatching in multiple avian species, including American kestrels (a model for the bald eagle) and common terns (populations decreasing), (2) to relate findings to field data including bioindicators such as P450 and oxidative stress for monitoring PCB contaminated ecosystems, (3) to examine combinations of different PCB congeners and other factors for interactive effects which may influence the outcome at the field level, and (4) to help establish PCB toxic equivalents for birds. The findings from this study will help to enhance scientific understanding of the natural and human-induced processes that influence the structure and function of biological systems as related to the Great Lakes ecosystem and other PCB-contaminated ecosystems in locations including New England. Collaborative partners include the FWS, the state of Maryland DNR and the Canadian Wildlife Service. New end points for biomonitoring and helping to assess the status and trends of biological resources of concern to the Department of the Interior and cooperating states will be published and presented at symposia.

Physiological and Teratogenic Effects of Mercury on Aquatic Birds Nesting Along the Mid-To Lower Carson River and Vicinity, Nevada

David J. Hoffman, Gary H. Heinz

Mining and milling operations in the middle Carson River Basin, Nevada, that peaked between 1865 and 1895, resulted in mercury contamination of the entire mid-to lower Carson River Basin, including wetlands in Lahontan Valley. In the Carson River system, levels of mercury in water, riverine sediments, and river bank materials have been found to be among the highest known worldwide. Lahontan Reservoir, the most important sport and commercial fishery on the Carson River system, supports a fish population containing some of the most elevated mercury concentrations in the drainage. This study is designed to evaluate the effects of mercury on reproductive success of aquatic birds, including fish-eating ones, with respect to threshold levels of effect (C.J. Henny, BRD) and useful biological indicators for monitoring. Potential biological indicators include teratogenesis, histopathology and physiological alterations. The findings from this study will help to enhance scientific understanding of the natural and human-induced processes that influence the structure and function of biological systems as related to mercury in riverine and reservoir ecosystems. Collaborative partners include EPA, the FWS, the BR, and the state of Nevada as well as academia. New end points for biological monitoring and helping to assessing the status and trends of biological resources of concern to the Department of the Interior and cooperating states will be published and presented at symposia.

Adaptive Management and Assessment of Habitat Changes on Migratory Birds

Richard Jachowski

Adaptive Natural Resources Management is still in its developmental stage, requiring a substantial research commitment and unprecedented collaboration between Federal research and management agencies. This work is the first phase of an interagency partnership that brings together an interdisciplinary team of biologists, geographic information specialists, and computer specialists at the USGS Patuxent Wildlife Research Center. This first phase utilizes a test system that already enjoys an extensive research and monitoring infrastructure. Aerial surveys conducted by the Fish and Wildlife Service in the wetlands and grasslands of mid continent United States will be enhanced with instrumentation to remotely collect habitat information simultaneously with species information. Survey and analytical modeling tools will be developed to feed back into an adaptive management approach, initially affecting both species management (hunting regulations) and habitat management responsibilities of the US Fish and Wildlife Service and to evaluate the efficacy of the North American Waterfowl and Wetlands Management Plan. First phase research elements focus on remote sensing and analytic tools development, including air reconnaissance design, systems design for geospatial habitat data from aerial, satellite and ground surveys, design of data management systems, development of procedures for habitat data display, habitat pattern recognition and interpretation, development of data integration capabilities, and modeling of habitat effects on species. Subsequent phases will involve refinement of ground based habitat/ population relationships, expansion to other wetland/waterfowl systems, and extension of the approaches and tools to other species of migratory birds in other habitats, including species at risk, endangered species and non-game migrant birds.

Body Condition and Muscle Protein of Wintering Black Ducks and Migratory Waterfowl on Wildlife Refuges

Dennis G. Jorde

Collaborators: Perry S. Barboza, George Washington University, Washington D.C.

We propose a series of experiments to establish a non-lethal method for assessing whole-body fuel metabolism in the black duck by simultaneously measuring body composition and protein metabolism. Appraisal of the phase of energy deficit or gain in the bird usually requires two measures of body composition to estimate net change. Unfortunately this is rarely feasible for migratory species. The combination of one indirect measure of body composition and a simultaneous assessment of protein metabolism would assess protein and fat reserves as well as indicating the stage of fuel metabolism. This technique could be more sensitive to subtle changes in fuel metabolism and thus more useful in predicting viability of flocks when combined with estimates of projected energy expenditure, food quality, and the frequency of weather restrictions on foraging.

The method will be validated by direct measures of body composition and nutrient balance in captive black ducks. Indirect estimates of body composition will be derived from dilution with labeled water. Protein metabolism will be measured by changes in muscle composition, proteolytic activity and the kinetics of labeled amino acids. Experiments on the effects of intermittent feeding, poor dietary quality, and seasonal activity on body composition and energy use will identify the limitations of the method and its predictive value. The resulting protocol will be applied to wild flocks of black ducks at participating National Wildlife Refuges along the migratory flyways to assess energy status of flocks over winter. Further studies may be performed with other species such as Canada geese and canvasbacks pursuant to the management need of National Wildlife Refuges.

Landscape-Level Determinants of the Distribution and Abundance of Black Ducks Wintering in Habitats Along the Atlantic Coast

Dennis G. Jorde, Jerry R. Longcore

More than 70 % of the continental population of black ducks winter in the Atlantic Flyway, mostly in estuarine habitats along the mid-Atlantic coast where segments of the population have shifted use of habitats and the size of the Atlantic Flyway population has declined. In response to a lawsuit about the population decline of black ducks, the United States implemented restrictive hunting regulations in 1983 and Canada did so in 1984 to reduce annual harvest. The number of black ducks counted during midwinter surveys did not respond as expected, partly because regulations in Canada were ineffective until after 1986 and retrieved kill in Canada did not decline appreciably until 1990. A question has been raised, however, about the ability of existing estuarine habitat along the Atlantic coast to provide the resources (in quantity and quality) for the current population of overwintering black ducks.

To address this issue we will focus on habitat changes at the landscape level for black ducks wintering in the Atlantic Flyway. We will determine changes as feasible in quantity and quality of estuarine habitat in recent years and relate those data to historical densities of wintering black duck populations in discrete habitat units, i.e., on the basis of an entire state or subsection of a state. We will then assess the potential of current habitats to winter more black ducks than are now (last 5 years) using those habitats.

Results of this project will provide data on the status of wintering habitats used by black ducks, which can be used by federal and state wildlife management agencies to protect or restore critical habitats on a state-wide basis. Perhaps data will enhance the ability to forecast population levels in concert with changes in estuarine habitat in the Atlantic Flyway in the future. Results will probably satisfy needs of the Atlantic Flyway Council regarding management of black duck populations and habitats and perhaps that of the Atlantic Habitat Joint Venture and Black Duck Joint Venture under the North American Waterfowl Management Plan.

Sustaining Wildlife Populations in Agricultural Landscapes: Landscape Model of the Relative use of Restored Wetlands by Migratory Birds

Cherry M.E. Keller

The U.S. Fish and Wildlife Service has opportunities to restore wetlands on private lands through its Partners for Wildlife Program. These restorations occur primarily in agricultural landscapes where wetlands have been drained and farmed. Restorations tend to be small and often isolated from other wetlands which can effect their use by migratory birds. How does the size and relative isolation of the wetlands influence its use by migratory birds? What other features of the wetland are influential in the relative use by wetland dependent species? How does the addition of the wetland enhance the biodiversity of the agricultural landscape? The relationship between migratory bird use of the wetland and physical features such as wetland size, isolation, shape and age will be examined. Answers to these questions will help the FWS to select restoration sites that are most likely to benefit migratory birds and ensure that the habitat restoration dollars are producing the desired results.

Technical Assistance to Fish and Wildlife Service - Chesapeake Bay Ecosystem

Cherry M. E. Keller

USGS Patuxent Wildlife Research Center and the U.S. Fish and Wildlife Service are sharing the costs of placing a researcher in the U.S. Fish and Wildlife Service's Chesapeake Bay Field Office to provide technical assistance to Field Office staff. The Field Office is continually involved in evaluating the wetland and wildlife impacts of large development projects such as the construction of water supply reservoirs, highways, and housing developments. On larger and more complex projects, the impacts include issues of forest fragmentation and often use the Habitat Evaluation Procedures and associated Habitat Suitability Models to try and quantify the habitat losses associated with these projects, and the potential habitat gains from proposed mitigation. Research papers have dealt with portions of these issues, but do not work through the application of these issue to the entire evaluation. There is a need to have someone involved who can provide technical expertise on habitat relations, forest fragmentation, and HEP and HSI models, as well as to develop new methods for improved evaluations. Technical assistance is being provided on these issues, and other researchers at Patuxent have been called in to provide their expertise on many other issues involving migratory birds, wetland mitigation and contaminants.. It is important that Field Office Staff be able to contact researchers, and bring their expertise to the decisions that are being made in the Field. It is also important that researchers understand some of the issues that biologists in the Field Offices are facing.

Evaluation of Methods for Designing Wildlife Studies

William L. Kendall

Collaborators: Michael Morrison, Sacramento State University, Kenneth Pollock,
North Carolina State University, William Block, U.S.D.A. Forest Service

Wildlife studies are varied. For example, scientific questions might involve populations, habitat, or entire ecosystems. The studies themselves might be observational or experimental. Because of the inherent variability in nature, and the difficulty in measuring aspects of natural processes, scientific rigor is needed in conducting wildlife studies. This book, coauthored by Michael Morrison of Sacramento State University, Kenneth Pollock of North Carolina State University, William Block of the U. S. Forest Service, and William Kendall of the U. S. Geological Survey, is intended to provide a guideline for designing wildlife studies, including both principles and examples. Chapter titles include Concepts, Experimental Designs, Sampling Strategies: Fundamental and Applications, Impact Assessment, Inventory and Monitoring Studies, and Synthesis.

Modeling and Management of Sandhill Crane Populations

William L. Kendall

Collaborators: Roderick Drewien and Stephen Nesbitt

There are six subspecies of sandhill cranes (*Grus canadensis*) endemic to North America. The greater sandhill crane (*G. c. tabida*) can be divided into several breeding populations. Two of these populations, the Rocky Mountain Population, and the Midcontinent Population are currently hunted. A third population, the Eastern Population, is currently not hunted, but the Mississippi Flyway is considering the possibility of opening a season. Proper management of these birds requires reasonable knowledge of their population dynamics and response to hunting. For the Rocky Mountain Population, much is known about their recruitment and some is known about their abundance and harvest levels, but little is known about their survival. One aspect of this project will be to computerize and analyze 20 years of mark/resight and recovery data for these cranes, for survival, movements, and their relationship to pertinent climatic and habitat variables. A second aspect of this project will be to develop a model of the population dynamics of the Rocky Mountain Population, to predict the impact of changes in harvest levels. A final aspect of this project will be to analyze mark/resighting data for the Eastern Population of greaters and the Florida sandhill crane, a threatened subspecies, which occur together on their wintering range. This information could be used in the management of the Florida sandhill, and in helping to evaluate the potential impacts of opening a hunting season on Eastern greaters.

Completed

Effects of Forest Management on Population Parameters and Habitat Use of Wood Thrushes

David G. Krementz

Collaborators: Michael J. Conroy

Forest fragmentation, nest parasitism and predation have been implicated in the decline of nearctic neotropical migrants. Further, forest management may play a role in these declines. We investigated the effects of forest management on wood thrush biology in the Piedmont of Georgia. We conducted a four year replicated, blocked experiment with two pre- and post-treatment years. We estimated breeding season survival rates, movement rates, production rates, habitat use and population abundances. In response to both thinning and prescribed winter burning, preliminary findings indicate that wood thrushes appear little influenced by forest management at the landscape level. We are conducting final analyses now.

Effects of Growing Season Prescribed Burns on Bachman's Sparrows

David G. Krementz

Growing season prescribed burns will be used more and more as a management tool on public lands to maintain and enhance sites for red-cockaded woodpeckers. The effects of these prescribed burns on non-target species is little known. Bachman's sparrows, a species of special concern, co-occur with red-cockaded woodpeckers and potentially might be negatively affected by growing season burns through both direct mortality and lowered recruitment. I propose to mark Bachman's sparrows with radio transmitters and follow the fates of sparrows both subjected to growing season burns and those not. Anticipated results should clearly demonstrate the direct effects (mortality) of such burns as well as the indirect effects (lower recruitment of birds directly affected and those in adjacent unburned stands). Proper timing of these prescribed burns may allow managers to manage for red-cockaded woodpeckers while not adversely affecting non-target species.

The Effects of Forest Management on Wintering American Woodcock Habitat Use and Survival Rates

David G. Krementz

Wintering American woodcock do not use all nocturnal habitats equally. In the Piedmont of Georgia, I have found that: (1) males and juvenile woodcock use fields at night more often than females and adults, respectively, (2) that old fields and clearcuts are used more often than hayfields or pastures, (3) that larger fields are used more often than smaller fields, and (4) that, on average, woodcock will not move far (<600 m) between a diurnal location and a nocturnal location. It is this last observation that has particularly intrigued me. Since all birds come out to nocturnal fields at least one in every three nights, it follows that the location of a nocturnal field suitable for roosting and foraging in might be important. I think that the use of fields at night is governed by three primary factors: 1) distance to suitable diurnal cover, 2) vegetation physiognomy, and 3) soil characteristics. I will investigate these hypotheses by marking with radio transmitters a sample of wintering woodcock in areas with various field types and locations. This two year study will include pre- and post-treatment years before and after clearcuts are made. I firmly believe that the placement and management of clearcuts can have a dramatic effect on the local distribution of wintering woodcock. I also believe that properly positioned fields will increase over-winter survival rates by increasing food availability, by reducing chances of predation through shorter crepuscular movements and through the provision of adequate cover in fields.

Technical Support of Partners in Flight

James A. Kushlan

Collaborator: Janet M. Ruth

The USGS is a signatory to Partners in Flight (PIF), a cooperative effort involving partnerships among federal, state and local government agencies, philanthropic foundations, conservation groups, industry, private individuals, etc. to promote the conservation of Western Hemisphere landbirds. As part of its responsibilities as a partner, USGS has named a representative to the PIF Federal Committee and a PIF Staff Coordinator for the bureau. The purpose of this project is to provide the support needed by the PIF Staff Coordinator to travel to appropriate PIF meetings and conferences. It also supports PIF activities that USGS wishes to support.

The role of the PIF Staff Coordinator is to represent USGS interests at PIF meetings and promote partnerships and exchange of information between USGS and other PIF partners. The activities of the PIF Staff Coordinator include the following: (1) attending the biannual meetings of the national PIF Management Steering Committee and the PIF Joint Committee; (2) evaluating PIF activities and projects to determine those to which USGS can contribute; (3) maintaining the PIF Home Page; and (4) compiling and disseminating information about PIF to USGS scientists and information about USGS activities to PIF partners.

Toxicity of Common Ions to the Amphipod, *Hyaella azteca*

Peter J. Lasier, Parley V. Winger

Toxicity testing and chemical analyses of sediment pore water have been suggested for use in sediment quality assessments and sediment toxicity identification evaluations. However, caution should be exercised in interpreting pore-water chemistry and toxicity because of inherent chemical characteristics and confounding relationships. High concentrations of common ions such as alkalinity (bicarbonate) and ammonium, which are typical of sediment pore waters from many regions, have been shown to be toxic to test animals. Toxicity tests are being conducted to establish acute toxicities of alkalinity and ammonia to *Hyaella azteca*, an amphipod commonly used for sediment and pore-water toxicity testing. Tests were conducted in serial dilutions of sodium bicarbonate solutions producing alkalinities ranging between 250 to 2000 mg/L as CaCO₃. Alkalinity was toxic at concentrations frequently encountered in sediment pore water. Ammonia is a product of decomposition that has also been identified as a potential toxicant in sediment pore water. However, there is considerable discrepancy in reported median lethal concentrations of ammonia for *Hyaella azteca*. Research is needed to investigate factors affecting ammonia toxicity to *Hyaella azteca*. Pore waters containing naturally produced ammonia will be used along with pore waters and reconstituted waters spiked with ammonia salts to evaluate the influence of factors such as dissolved organic carbon, major cation concentrations, ionic strength and animal age to ammonia toxicity. Alkalinity and ammonia should be routinely measured in pore-water toxicity tests, and interpretation of toxicity should consider concentrations of these ions and test-organism.

Contaminant Impacts to Early Life Stages of Robust Redhorse (*Moxostoma Robustum*) in the Lower Oconee River, Georgia

Peter J. Lasier

Collaborator: Parley V. Winger

The robust redhorse (*Moxostoma robustum*) was rediscovered in the Oconee River, GA in 1991 after being thought extinct for over 100 years. The aging population of between 1000 and 3000 fish have been observed spawning, but survival of offspring is low or nonexistent, prompting a collaborative effort between university, state, federal and private enterprise personnel to artificially propagate the species for reintroduction as opposed to listing the species as endangered. The role of contaminants and water quality in the survival of early life stages of this species is unknown. This project will assess potential contaminant impacts in the watershed through field and laboratory investigations. Reconnaissance studies of sediment, pore water and surface water toxicity will be conducted using *Hyaella azteca* and *Ceriodaphnia dubia* in chronic tests that will be accompanied by analytical analyses of sediment and pore water samples. During spawning activities in late spring, the sensitivities of robust redhorse eggs, yolk-sac fry and swim-up fry will be determined for pore waters and surface waters collected *in situ* as well as for contaminants permitted for discharge and found in the watershed.

Development of New Statistical Methods for Biological Applications

William A. Link, Jeffrey S. Hatfield, William L. Kendall

Many of the practical and theoretical problems encountered by biologists in measuring and interpreting population parameters lack established methods of data collection and analysis. The greater the complexities accompanying such problems, the more likely it is that the application of standard statistical methods will lead to unsatisfactory solutions and to the obscuring rather than revelation of true patterns in data. This work unit allows biological metricians to appraise the applicability of existing methodologies, to modify them as necessary, and to develop new techniques when existing methods are inadequate.

Modeling Temporal and Geographic Aspects of Population Change

William A. Link, John R. Sauer, James E. Hines

Count surveys such as the North American Breeding Bird Survey and the Christmas Bird Count are important information sources for managers and scientists. However, their use in management is often limited by both inappropriate analyses and limited access to information. In earlier work (e.g., Link and Sauer 1997, Biometrics), we have developed new procedures for analyses of count survey data that allow incorporation of factors that influence counts. We have also implemented internet-based programs for summary and display of BBS data (Sauer et al. 1997. <http://www.mbr.nbs.gov>). In this study, we extend the methods for survey analysis, implement the new methods for analysis of count data for all species in the BBS, apply the procedures to a variety of other surveys used for population management, develop user-accessible software for population change analysis, and make the new methods available to users over the internet.

Completed

Survival of Juvenile Female Black Ducks and Mallards During Staging and Migration to Atlantic Coast Wintering Areas

Jerry R. Longcore, Daniel G. McAuley

Collaborators: G. A. Parker, Canadian Wildlife Service, Atlantic Region; J. F. Giroux, University of Quebec at Montreal; P. Dupuis, Canadian Wildlife Service, Quebec Region

Analysis of band recoveries have been inadequate in relating harvest to population change for black ducks. Hunting losses have been viewed mostly as compensatory up to some unknown threshold, but thereafter are additive and affect the breeding population of the next spring season. This phenomenon is especially relevant when hunting losses occur on or near the breeding grounds, such as on staging areas. This Study Plan uses telemetry to document black duck mortality from all causes at 3 locations (Quebec, Nova Scotia, Vermont/Quebec border) in conjunction with the CWS and Provincial fish and wildlife agencies, and to determine Kaplan-Meier survival estimates. Survival of mallards also is evaluated on the VT/Quebec area.

Completed

An Evaluation of Visibility Bias of Waterfowl Broods Using Helicopters on Beaver Pond Habitat in Eastern Ontario

Jerry R. Longcore, Daniel G. McAuley, David A. Clugston

Collaborators: Bruce Pollard and T. Shane Gabor, Institute for Waterfowl and Wetland Research, Ducks Unlimited, Inc. Manitoba, Canada

Helicopter surveys are perceived as a technique that is logistically and economically feasible for determining density indices of forest-dwelling waterfowl in expansive forested landscapes. Although helicopter surveys for breeding pairs produce results similar to those of ground surveys, recent cooperative work with Ducks Unlimited staff in Nova Scotia revealed that helicopter surveys for waterfowl broods failed to detect 50% of all waterfowl broods and 70% of the black duck broods. To determine the reliability of helicopter surveys in Ontario for waterfowl broods, simultaneous ground counts will be conducted to assess numbers detected, and the behavior of ducks in response to the sight and sound of the helicopter will be evaluated.

**Productivity of Sympatrically Breeding Black Ducks and Mallards on Wetlands of Forested and Agricultural Landscapes in Maine
(includes data on behavioral interactions of these species)**

Jerry R. Longcore, Daniel G. McAuley

In previous papers researchers have hypothesized that hybridization and competitive exclusion were the primary causes of the decline of the American black duck. These authors speculated that mallards forced black ducks from fertile wetlands onto less fertile wetlands where they produced fewer young. This work during 1992 and 1993 was initiated to evaluate the hypothesis that black ducks and mallards produced fledged broods of different sizes. In regard to competitive exclusion, it has been speculated that black ducks were excluded from wetlands by mallards and alleged the principal cause of the black duck decline. We studied sympatric populations of black ducks and mallards in Maine during breeding to document behavior and interactions between black ducks and mallards.

Variables Affecting the Black Duck Decline and Current Status of Black Ducks and Mallards in Southern Ontario

Jerry R. Longcore, Daniel G. McAuley

During the 1950s through the early 1980s the continental wintering population of black ducks declined substantially (~50-60%) to its current number of just under 300,000. Through 1968 most biologists in the United States and in Canada believed that the black duck population, especially juveniles and females, was over exploited by hunters on the breeding grounds, thus causing the population to decline. Plans were underway between the United States and Canada to reduce harvest, but a harvest-reduction program was not initiated until after a lawsuit against the F&WS in 1982 and more restrictive regulations were instituted in early 1983 in the U.S. and in 1984 in Canada. Following this action U.S. harvest was substantially reduced (~40%), but harvest in Canada did not decline appreciably until 1990. More recently through 1996 estimated indicated pairs of black ducks in the areas surveyed by helicopter in Canada have varied between 102,000 and 153,000. Since 34,000 black duck pairs were counted in Ontario in 1990, the number of indicated pairs in Ontario has been greater in 5 of 6 years, ranging between 38,409 and 42,085 pairs, suggesting that the increased reductions in Canadian harvest are helping to restore the breeding population. If sufficient evidence can be assembled to depict that harvest can play an important role in affecting population size, then U.S. and Canadian migratory bird administrators can better justify their joint regulatory actions to restore the black duck breeding population. An example of a depauperate black duck breeding population, relative to that of previous years, is that of southern Ontario where the black duck population declined consistently until more restrictive harvest regulations in recent years. The cause of the decline has fueled much speculation about hybridization and competitive exclusion from mallards. Many other relevant variables (e.g., sex and age ratios in harvest, duck stamp sales, bag limits, season lengths, land conversion rates, wetland changes, human population changes) have not been examined in concert with changes in retrieved kill and the Mid-winter Inventory to determine patterns of population change. We propose to determine relationships among the preceding variables for the period of black duck decline and mallard increase in southern Ontario and to identify the combined variables that might have affected the status of the black duck population.

American Black Duck (Birds of North America Series)

Jerry R. Longcore

Collaborator: Daniel G. McAuley

The Birds of North America (BNA) series provides comprehensive, authoritative summaries of current knowledge of the breeding bird species of North America. This task will complete the review for the American black duck.

Survey of Natural Cavities Suitable for Waterfowl on Sunhaze NWR, ME

Jerry R. Longcore

Collaborator: David A. Clugston

Refuge personnel are debating the need to erect nest boxes on refuge lands because they do not know the status of natural cavities. This proposed task is to assist the Sunhaze NWR staff in their decision-making on management needs. With standard, published survey methods we will determine the numbers, by forest type on the refuge, and evaluate the suitability of cavities for hole-nesting waterfowl.

Mercury in Tree Swallows and Feathers of Other Species That Line Tree Swallow Nests at Acadia National Park, Maine

Jerry R. Longcore, Daniel G. McAuley

Collaborators: Terry A. Haines, OFS, Leetown Science Center;
Carla J. Dove, National Museum of Natural History

Freshwater ecosystems at Acadia National Park (ANP) in Maine have significant ecological, aesthetic, recreational and community values and even provide habitat for two federally listed endangered bird species (bald eagle [*Haliaeetus leucocephalus*], peregrine falcon [*Falco peregrinus*]). Water resources in the park are threatened by point and non-point sources of pollution (e.g., atmospheric deposition of acids and toxic substances, including heavy metals). Recent preliminary results of sampling by T.A. Haines (OFS, Leetown Science Center, USGS) revealed high amounts (≥ 0.5 ppm) of mercury in about half the fish sampled in 20 lakes in Maine, and extremely high amounts (0.53-3.9 ppm) in fish from two lakes in Acadia National Park. Dr. Haines is intensively studying these lakes to determine mercury uptake through the food chain, which will include sampling aquatic invertebrates, fish, reptiles, and piscivorous birds. We propose to complement that sampling of different trophic levels by collecting biological samples from the tree swallow, an insectivorous species, to relate to Dr. Haines' aquatic insect samples. Eggs, nestlings food boli, feathers (and perhaps blood from nestlings) would be sampled from boxes erected near the ANP ponds. A secondary objective would be to examine the bird feathers used by tree swallows to line their nests. Male tree swallows bring feathers of other species to the nest cavity to line the nest. Scattered records have identified a few species whose feathers are used, but no systematic effort has been made to determine which bird's feathers predominate and how associated to habitat. After that is determined we can assess the feasibility of monitoring nest boxes to sample different types for mercury in other obligate avian wetland species.

Bioavailability and Potential Effects of Mercury and other Selected Trace Metals on Biota in Plow Shop and Grove Pond, Fort Devens, MA

Jerry R. Longcore

Collaborator: Terry A. Haines

Plow Shop and Grove ponds are small (12 and 24 ha surface area, respectively), shallow impoundments located just of the Main Post of Fort Devens in the town of Ayer, MA. Both ponds are used by area residents for recreational fishing and both provide significant habitat for fish and water birds. Previous investigations have determined that pond sediments are enriched in a number of trace metals, including, arsenic, cadmium, chromium, copper, lead, manganese, mercury, vanadium and zinc. Several potential sources of these contaminants exist, including a former tannery on Grove Pond, a former railroad roundhouse on Plow Shop Pond, and a closed landfill adjacent to Plow Shop Pond. Analysis of fish tissue from the ponds indicates extremely high levels of mercury, which is one of the few metals that bio-accumulates through aquatic food chains. Some of the sediment metals (e.g., arsenic, chromium, copper) may be toxic to benthic invertebrates inhabiting the sediments. The mercury may be methylated by bacteria in the sediments, then accumulated to potentially hazardous levels by invertebrates and eventually fish, insectivorous birds, and piscivorous birds. Metals in many fish samples exceeded the U.S. Food and Drug Administration mercury guidelines for human consumption, as well as wildlife hazard indices.

Completed

Assessment of Zebra Mussels (*Dreissena polymorpha*) as a Source of Contaminant Exposure for Diving Ducks

Peter Lowe

Zebra mussels, a species recently introduced into North America, has become an important food source for diving ducks in many locations. Their ability to accumulate high concentrations is well known. This study was undertaken to evaluate zebra mussels over traditional food organisms as a source of contaminant exposure by diving ducks. Zebra mussels and *Gammarus fasciatus*, a potential traditional food organism, were collected from 16 sites in Lake Ontario and Lake Erie where diving ducks congregate during the fall of 1993 and 1994. The sites receive a range of metal contaminant exposures. Sediment samples were collected to compare environmental conditions among locations. An ICP scan and mercury analyses were performed at a commercial laboratory.

Effects of Temephos and Methoprene on Macroinvertebrates and Amphibian Larvae in Freshwater Macrocosms

Peter Lowe, Donald W. Sparling

Collaborators: Alfred Pinkney, U.S. Fish and Wildlife Service, Chesapeake Bay Field Office

The USGS Patuxent Wildlife Research Center (PWRC) and Chesapeake Bay Field Office (CBFO) of the Fish and Wildlife Service initiated studies of the effects of mosquito control pesticides on non-target species in 1994. This study is part of an FWS evaluation of the impact on non-target organisms of pesticide usage NWRs. It is a continuation of that effort, was conducted on experimental wetlands at PWRC to evaluate the effects of temephos (Abate) in low pH, fresh water environments and to compare the impacts of temephos and methoprene (Altosid), another mosquito control agent. The PWRC is responsible for studying the impacts on amphibian larval and zooplankton crustacean; CBFO is responsible for studying the impacts on emergent insects. Abate retarded growth rates of gray treefrog (*Hyla versicolor*) tadpoles whereas growth rates of tadpoles exposed to Altosid were unaffected. The 96 hr LC₅₀ was 4.24 $\mu\text{L}\cdot\text{L}^{-1}$ and the slope (\pm S.E.) was 1.917 (\pm 0.594) $\mu\text{L}\cdot\text{L}^{-1}$ and the butyrylcholinesterase was significantly depressed at an Abate concentration of 1.86 $\mu\text{L}\cdot\text{L}^{-1}$ whereas acetylcholinesterase was not depressed even at Abate concentrations of 10 $\mu\text{L}\cdot\text{L}^{-1}$. Although 4 tadpoles exposed to mid-level concentrations of Altosid died, none died at the highest concentration (100 $\mu\text{L}\cdot\text{L}^{-1}$) precluding calculation of a dose response curve. After the first spraying of experimental wetlands sprayed with Abate, the Shannon diversity index and species richness were reduced ($p < 0.002$) and the average number of species emerging from in wetlands was reduced 3.8 to 8.4 species. These reductions persisted throughout the spraying season. The average number of species was reduced after the first spraying with Altosid from 7.2 to 11.5 species but recovered by the last spraying. Preliminary evaluations of *Daphnia magna* survival when exposed to various dilutions of water from wetlands sprayed with Abate showed that solutions composed of 4% of sprayed wetland water 96% reconstituted water may be toxic to the animal. Zooplankton assessments are underway.

Complete

Evaluating the Environmental Impacts of the Whitewater Recreation Industry on Five West Virginia Rivers

Jeffrey L. Marion

Managers of protected areas must balance the provision of recreational use with their associated effects on natural environments and processes. This study examines the environmental impacts of whitewater recreation use along five rivers in West Virginia (the New, Gauley, Cheat, Shenandoah, and Tygart rivers). Project work includes identifying, inventorying, and monitoring environmental impacts associated with river recreation use at river access roads, boat launching/landing sites, day use areas, and overnight camping sites. Study results will be integrated with findings from parallel social science research to develop a Limits of Acceptable Change management framework for the study rivers. This is a collaborative study with forest recreation faculty at West Virginia University serving clients that include the West Virginia Division of Natural Resources, the West Virginia Whitewater Commission, and three National Park Service units (New River Gorge National River, Gauley River National Recreation Area, and Harpers Ferry National Historic Park).

Managing the Environmental Effects of Off-Road Vehicles in Big Cypress National Preserve, Florida

Jeffrey L. Marion

Collaborators: Dr. Joe Roggenbuck, Virginia Tech, Faculty;
Dr. Dale Blahna, Utah State Univ., Faculty

This study investigates the environmental impacts and management options for off-road vehicles (ORV's: swamp buggies, all-terrain vehicles, street-legal 4x4's, and airboats) operated in Big Cypress National Preserve, Florida. A plan is being developed to provide guidance to the National Park Service for managing ORV use in a manner that minimizes effects to park resources and other visitors. This controversial effort includes extensive public involvement. Research focuses on evaluating ORV environmental impacts and conflicts with other visitor groups. Social science surveys are being conducted to evaluate how ORV's are used by both hunters and non-hunters, to describe the current distribution and amount of use, and to evaluate how ORV use affects other visitor groups. ORV Best Management Practices are being developed and evaluated.

Completed

Effectiveness of Campsite Siting and Design in Minimizing Camping Impacts at Isle Royale National Park

Jeffrey L. Marion

Recreation site selection and design can help protected area managers minimize visitor impacts by concentrating visitor activities, reducing the area of disturbance that would occur under unregulated visitor use or dispersal strategies. This study evaluates the effectiveness of backcountry campsite management actions employed at Isle Royale National Park through the development and application of a campsite monitoring program. Data from this study will also be used to provide baseline information for a Limits of Acceptable Change management framework currently being incorporated into the park's General Management Plan. Data from future monitoring cycles will be used to evaluate management standards and the effectiveness of management actions implemented to keep campsite conditions within standards.

Completed

Evaluating Factors Affecting Trail Degradation in Great Smoky Mountains National Park

Jeffrey L. Marion

Deteriorating trail conditions in Great Smoky Mountains National Park are the focus of a controversy between horseback riders and hikers in this heavily visited park. Trail condition survey techniques were developed and applied to 328 miles of backcountry trails in an effort to improve our understanding of trail degradation processes. Trail conditions were described and analyses revealed the relative influence of factors contributing to trail degradation, including environmental attributes, trail design and maintenance, and type and amount of use. A planning document was prepared to guide future visitor and resource management efforts for improving trail conditions.

Completed

Evaluation of Strategies for Minimizing Camping Impacts at Shenandoah and Great Smoky Mountains National Parks

Jeffrey L. Marion

Two primary strategies employed by protected area managers to minimize recreational impacts are visitor dispersal and visitor concentration. This study seeks to empirically evaluate the effectiveness of Shenandoah National Park's dispersed camping policies and Great Smoky Mountain National Park's designated site camping policies. Campsite impact monitoring systems were developed and applied to all back country campsites in each park to characterize campsite conditions and permit analyses of aggregate change and the influence of use-related, environmental, and managerial factors.

Response of Avian Communities to Forest Management on Moosehorn National Wildlife Refuge

Daniel G. McAuley, Jerry R. Longcore

Moosehorn National Wildlife Refuge (MNWR) was established as a management area for American woodcock (*Scolopax minor*). Since 1979, 40-60 ha of habitat are clearcut each year. During 1978-81, point counts were used to determine species richness and relative abundance of birds in conifer, hardwood, and mixed-wood control (uncut) and treatment (clearcut 0-8 yrs. old) sites. Numbers of species increased in treatment plots. Increases in estimated richness and diversity were noted in treated hardwood and mixed growth stands. Of the 68 species of birds recorded, 17 increased in relative abundance, whereas only 2 species (red-breasted nuthatch [*Sitta canadensis*] and Cape May warbler [*Dendroica tigrina*]) declined after clearcutting began. The refuge now contains patches of the original forest (~5,070 ha), which includes a 2,000 ha permanent wilderness area and is interspersed with clearcut blocks and strips ≤ 15 years old (~850 ha).

Avian species were censused again during late May and June in 1995 and 1996 using point counts. Surveys were done twice each year. Observation periods lasted 10 minutes. Ten plots were established in 12 habitat types: uncut (controls) (1) hardwood, (2) conifer, and (3) mixed growth stands in the management area; 8 - 15-year-old clearcuts (treatment 1) in (4) hardwood, (5) conifer, and (6) mixed growth stands; 1 - 3-year-old clearcuts (treatment 2) in (7) hardwood, (8) conifer and (9) mixed growth; and (10) hardwood, (11) conifer and (12) mixed growth stands in the wilderness area (unmanaged contiguous forest). We will compare survey data from recent clearcuts vs. 15-year-old clearcuts vs. uncut forest; and the 1978-81 census vs. present census to evaluate the effects of habitat management on the avian community.

Effect of Hunting on Survival and Habitat Use by American Woodcock (*Scolopax minor*) on Breeding and Migration Areas

Daniel G. McAuley, Jerry R. Longcore

Collaborators: Greg F. Sepik, Region 5, Woodcock Specialist - USFWS, R. Bradford Allen ,
Biologist - ME DIFW, Bill Palmer and John Dunn , Biologists - PA Game Commission

The American woodcock (*Scolopax minor*) population has declined over the last 29 years at an annual rate of 2.5% in the Eastern region and 1.6% in the Central region. In 1996, the breeding population index in the Eastern region was the lowest on record. The major causes of the decline are thought to be degradation and loss of suitable habitat on breeding and wintering areas. Although hunting is not thought to be a cause of the decline, hunting mortality can be controlled and research on the effects of hunting mortality on woodcock populations at both local and regional levels is lacking. In 1985, season length and bag limits in the Eastern region were reduced in an effort to stabilize the population decline. Despite these efforts woodcock populations in every state in the Eastern region have continued to decline. Estimates of the retrieved kill of woodcock have increased from 789,000 in 1969 to 1,328,000 (U. S. only) in 1977 to 2,000,000 in 1990. These data suggest an increasing annual mortality from hunting. Because habitat quality and quantity has been declining along with the woodcock population, woodcock harvest may now be above acceptable levels.

We will use radio-telemetry to determine sources of mortality, survival rates, habitat use, and movement of woodcock during fall on local areas within the breeding range of the woodcock. Also, we will determine effects of fall survival on size of the spring population. If enough funding and partner interest can be obtained we will attempt a similar effort on staging areas during migration. This study will be a cooperative venture among PWRC, USFWS-Region 5, Moosehorn NWR, Maine Department of Inland Fisheries and Wildlife, PA Game Commission, and Erie NWR, The Ruffed Grouse Society, Champion International Corp, Dartmouth College and the Wildlife Management Institute.

Systematics and Zoogeography of Amphibian and Reptile Species

Roy W. McDiarmid

Amphibians and reptiles are important but not well understood components of most ecosystems. As knowledge of their functional roles in specific habitats increases, the need to maintain expertise within BRD about the systematics, ecology, distribution, and life history of species concomitantly expands.

Understanding what species occur where requires current knowledge of their taxonomy and phylogenetic relationships. As pressures on amphibian and reptile populations from habitat degradation and loss accelerate, a solid systematic foundation is essential to the success of species conservation and management efforts. The predictive value of phylogenetic hypotheses is becoming more and more obvious to basic research and successful management activities. This project addresses specific taxonomic/systematic problems based on field research and morphological investigation of specimens housed in the National Museum.

A Review and Synthesis of the Biology of North American Amphibian Larvae and Biology of Tadpoles

Roy W. McDiarmid

Collaborators: Ron Altig, Department of Biology, Mississippi State University

The tadpoles of anuran amphibians are important components of aquatic systems and serve as major elements in energy transfer from aquatic to terrestrial habitats. In addition, tadpoles are significant links in the aquatic food chain, especially in ephemeral wetlands. Basic research with tadpoles has increased tremendously in the past 15 years and important aspects of their basic ecologies are better known. Yet, application of this knowledge has been hampered by the difficulty of identifying tadpoles in the field and the lack of a readily available synthesis of their morphology, ecology, behavior and diversity. This project will provide a synthesis of the biology of anuran larvae to facilitate their use in various kinds of research, both basic and applied. This synthesis will take the form of a major reference that brings together all information on the biology of these unique organisms. A different but related project will synthesize the extensive, scattered scientific literature on the biology of North American amphibian larvae and provide keys, morphological descriptions and illustrations of all North American species to allow their identification in field conditions.

Computerization of the Biological Survey Locality File and Geographical Coding of Vertebrate Collections in the National Museum of Natural History

Roy W. McDiarmid

Starting in 1885 the Biological Survey collected specimens of vertebrates to inventory and document the natural resources of North America. More than 800,000 specimens resulted (curated by NBS museum personnel) were and continue to be the basis for hundreds of scientific papers on vertebrate systematics and ecology and a tremendous source of distributional and temporal data about the North American fauna. While most specimen records are available electronically, only a few include latitude and longitude; therefore, this resource is only marginally useful for GIS and other mapping applications. A major task of Survey staff in the late 1800s and first half of this century was to plot vertebrate species distributions. As locality records were transcribed from specimen tags to maps, a file of Survey localities was begun. This file (about 20,000 localities) of 3x5 cards fills 15 drawers. Localities are arranged alphabetically without regard to State, and often have descriptions of the locality and associated habitat, dates of visits, collector(s) names, and sometimes latitude and longitude. Mapping activities and card file maintenance ceased in 1950. We are building an electronic copy of the Biological Survey locality file. We hope eventually to be able to enhance each record with coordinate data from the Geographic Names Information System (the U.S. Geological Survey's Board of Geographic Names digital gazetteer) and establish a protocol to associate geocoordinates with specimen records in the National Museum. Completion of the project will make thousands of records of National Museum specimens available for use in GIS and similar projects by the NBS and other partner organizations.

Snake Species of the World - A Taxonomic and Geographical Reference

Roy W. McDiarmid

The ability to inventory species that make up biological communities in many parts of the world, and even for those within the Western Hemisphere, often is hampered by the lack of published summaries of the scientific and taxonomic literature, and other information on those faunas. Understanding what species of amphibians and reptiles occur where often is integral to proper planning for conservation and management projects, and for evaluation of areas and habitats subject to commercial exploitation, but information on these important vertebrate groups remains poorly reviewed in many geographic areas of the world. The National Museum of Natural History is a leader in the field of taxonomic, evolutionary, and biogeographic studies and is in a position to contribute in a major way towards establishing the taxonomic underpinnings so necessary to understanding biodiversity on a world scale. A recently completed compilation of Amphibian Species of the World (Frost, 1985) has greatly advanced our ability to consider amphibians in broader studies of ecology and biodiversity. The published results of this project will include a thorough review and compilation of pertinent literature on snakes in three volume work titled Snake Species of the World; it will serve as companion volumes to that on amphibians. The last comprehensive work on snakes was published in 1886. These volumes represent coverage of an important group of vertebrates and constitute a crucial and baseline reference for ongoing studies of vertebrate communities, biodiversity, and ecosystem management.

Vertebrate Checklist and ITIS Activities

Roy W. McDiarmid, Richard C. Banks, Alfred L. Gardner

Collaborators: Wayne Starnes, North Carolina State Museum of Natural Science

Access to consistent, scientifically credible taxonomic information is essential to many governmental activities including environmental monitoring, natural resources management for sustained use, land owner assistance, waste management, environmental regulation, and biotechnology development. Resource use and conservation goals established as part of such activities rely upon contributions from many agencies, and, in part, on accurate inventories of the diversity and distribution of biological resources. The storage and retrieval of biological data require a high quality, well-documented, and continuously updated source of taxonomic information. PWRC scientists and collaborators have been asked to provide vertebrate information for the Integrated Taxonomic Information System (ITIS). The ITIS project is part of a general framework of cooperation among the federal agencies and the scientific community to develop, review the content of, continuously improve, and maintain a taxonomic information system to be used by the signatory agencies and others. The end product integrates taxonomic information into an information system that can be utilized by all signatory agencies, other federal agencies and the public. In addition, the project will provide a means to collaborate on research and evaluation programs and to exchange information and resource expertise among interested users. The PWRC team will serve in a peer-review capacity and revise taxonomic and nomenclatural treatments of vertebrates, house the database within PWRC facilities, make taxonomic information more accessible to its intended users, and work to develop better links between the scientific needs of the taxonomic community and the applied needs of the Federal government.

Effects of PCBs on Reproduction and Biomarker Responses in Tree Swallows at Contaminated Sites in the Eastern Region

Mark J. Melancon, Barnett A. Rattner, David J. Hoffman

Collaborators: Diane Henshel, Indiana University; John Stegeman, Woods Hole Oceanographic Institute; Dan Sparks, FWS Region 3; Mary Haasch, University of Maryland; Amy Yorks, University of Maryland

This study was developed in response to a request by the State of Pennsylvania and the NBS cooperative fish and wildlife research unit at Pennsylvania State University for an approach to evaluate possible harm to avian wildlife from PCBs in contaminated habitats. A related study (60005.02) deals with a mammalian species. Meetings and discussions to develop these studies included participation by several Pennsylvania state agencies, several NBS facilities, the Fish and Wildlife Service and the National Park Service.

The goals of this study are: 1-To develop several biomarkers for PCB exposure in nestling Tree swallows; 2-To collect nestling Tree swallows from a number of sites with a range of PCB concentrations and assess biomarkers, PCB concentrations and reproductive and other health-related parameters; 3-To utilize these data to evaluate any detrimental effects of PCBs on reproduction and on the nestling Tree swallows, and to field validate the biomarkers for PCB exposure and effect in this species; and 4-To prepare a summary of these results that will be of value to game management staff in assessing possible harm to wildlife by PCB contamination.

The Tree Swallow was selected as a sentinel species because it can be attracted to nest boxes, has reasonably limited feeding areas, is commonly found in the region of study, and is likely to be exposed to PCB contamination through consumption of emerging aquatic insects. Studies are planned or in process at eight sites comprising a range of PCB concentrations. In addition arrangements have been made to obtain samples collected by others from a superfund site. Twelve-day-old nestlings were selected for study because they represent an extremely sensitive life stage, samples are easily obtained, and the PCBs accumulated in the body have come from food taken locally. One nestling is sacrificed from each nest box for a maximum of twenty nestlings per site. The remaining nestlings in each clutch are banded to assess site fidelity in subsequent years of sampling. Parameters examined include: body weight, tibiotarsus length, radius-ulna length, culmen length, heart weight, liver weight, clutch size, and cytochrome P450. Bilateral bone measurements are taken to analyze skeletal symmetry. In samples collected at seven sites in the first year of the study, two monooxygenase activities were elevated at several sites, but no significant differences were observed between sites for the other biological parameters measured. There is a correlation between cytochrome P450 and PCBs in the samples analyzed to date. Sample collection for the second field season has been completed. Chemical and biochemical analyses are proceeding. Daniel Sparks and Anne Secord of the USFWS are helping to provide samples from two sites and Diane Henshel (Indiana University), John Stegeman (Woods Hole Oceanographic Institute), and Mary Haasch (University of Maryland) are participating in the laboratory studies.

Providing Technical Support, Primarily Biomarker Analysis Using Established Methods

Mark J. Melancon, Donald W. Sparling, Barnett A. Rattner, David J. Hoffman

Patuxent Wildlife Research Center Scientists frequently get requests from other units of the Department of the Interior, primarily the Fish and Wildlife Service, to provide expertise in assessment of contaminant impacts on wildlife and trust lands. Such requests also arise from other units of the Federal Government and from State Governments. This assessment may require laboratory assay of biomarker responses. By providing this assistance we not only aid our sister Agencies in generating and evaluating the data, but increase our awareness of current contaminant problems and concerns. This in turn may lead to internal research projects, larger roles in NRDA's, etc.

It is expected that the requesting agency would pay for the needed assays, etc.(technician time, supplies, equipment maintenance). The technical support intended under this study would include relatively small projects utilizing methodology already in place at the Patuxent Wildlife Research Center, with costs totaling less than approximately \$10,000.00 per project. Any scientist on Center may include such projects under this study as a co-investigator; currently Don Sparling has the cholinesterase work and Barnett Rattner the colonial waterbird listed under item 4 below. More extensive projects, particularly those involving new methods development, would probably require separate study plans.

Currently there are seven projects that fall under this classification. 1. Assessment of hepatic microsomal monooxygenase activity in surf scoters for the FWS as part of the Avian Injury Reconnaissance effort of Phase II of the Commencement Bay NRDA. 2. Providing technical assistance for the FWS on NRDA activities associated with the VERTAC Superfund Site, Jacksonville, Arkansas. 3. Assessment of hepatic microsomal monooxygenase activity in bullheads from locations on the Potomac River for the FWS as part of a study on tumors in fish. 4. Assessment of cholinesterase activity and hepatic microsomal monooxygenase activity for the FWS as part of the Great Salt Lake Contaminant Assessment/ National Irrigation Water Quality Program. 5. Investigation of PAH and PCB contamination at the Mason Neck National Wildlife Refuge Complex. 6. Contaminant impacts on the Pea Patch Island heronry, and 7. Contaminant (particularly PCB) effects on snapping turtles.

Development of Microsomal P450 as a Bioindicator for Environmental Contaminant Exposure

Mark J. Melancon, George F. Gee, Glenn Olsen, Barnett Rattner, David Hoffman

Collaborators: Tom Custer, Upper Mississippi Science Center; John Stegeman, Woods Hole Oceanographic Institution, Mike McKee, previously at Southern Illinois University, Patricia Levi, previously at North Carolina State University

Cytochromes P450 and associated monooxygenases can serve for biological monitoring for environmental contaminants because they are induced by a variety of environmental contaminants. For some of these contaminants biological monitoring would be much less expensive than chemical analysis (extraction, clean-up and GC/MS). In many cases induction of cytochromes P450 is the most sensitive response to a particular type of contaminant. This study was developed to increase the avian species for which methodology was available for cytochrome P450 as a biomarker for contaminant exposure. The primary method was assaying for cytochrome P450-associated monooxygenases using a computer-coupled fluorescence microwell plate scanner, but gel electrophoresis, western blotting, and addition of *in vitro* cytochrome P450 modulators to the monooxygenase assays were also studied. The species studied represent a mix of preselected sentinel species, species for which cytochrome P450 evaluation was necessary because of specific problems, and species which became available from other studies. The species that have been studied include Mallard duck, Black duck, Wood duck, Lesser scaup, Double-crested cormorant, Black-crowned Night heron, Great blue heron, Florida sandhill crane, Black-necked stilt, American avocet, Red-winged blackbird, European starling, Tree swallow, Barn swallow, Northern bobwhite, American kestrel, Screech owl, Forster's tern, Caspian tern, Western sandpiper, Canada goose, Mute swan and Ringnecked pheasant. The project was expanded beyond birds to include frogs. The methods have been applied to 14 species in field evaluation of contaminant exposure.

Development of Mixed Function Oxidase as a Bioindicator Model for Assessing Contaminant Exposure in Avian Embryos: Application for Field Bioassessments

Mark J. Melancon

Collaborators: Diane Beeman, Cooperative Education Agreement, Ph.D. candidate at North Carolina State University, Jim Fleming, (was leader of North Carolina Cooperative Fish and Wildlife Research Unit and major thesis advisor when study began)

Polychlorinated dibenzodioxins (PCDDs) and Polychlorinated dibenzofurans (PCDFs) have been found in southern river systems on which paper pulp bleaching occurs, and there is concern about harm to wildlife in those areas. Wood ducks utilize this type of habitat and at least one previous study demonstrated their exposure to these contaminants. The current study was designed to develop cytochrome P450 as a biological marker of contaminant exposure in wood ducks and to apply this approach along with reproduction and health indicators in wood ducks on several rivers in the southeastern United States. The study involved pen/laboratory work and field application. The pen/laboratory work required exposure of wood ducks ranging in age from embryo to subadult to prototype inducers of cytochromes P450 so that assay conditions for four cytochrome P450-associated monooxygenases and responsiveness could be determined. Subsequently these enzyme assays, along with assessment of reproduction and contaminant body burdens, could be applied to wood ducks from control and suspect locations.

Habitat Selection, Productivity and Survival of Shrub-Scrub Neotropical Migratory Birds in the Southeastern United States

J. Michael Meyers, Donald H. White, Cameron B. Kepler, Paul W. Sykes, Jr.

Analyses of North American Breeding Bird Surveys have revealed that many populations of Neotropical migratory birds have declined significantly throughout their range. These documented declines have been associated with fragmentation of eastern forest habitat into isolated patches, loss of wintering habitat in Central and South America, loss or significant alternation of optimum breeding habitat ("source" versus "sink" habitat), and nest parasitism by the Brown-headed Cowbird (*Molothrus ater*). We are studying the ecology of the Painted Bunting (*Passerina ciris*), a species-at-risk, on coastal barrier islands, a physiographic area of high importance in the southeastern U. S. Unlike forest interior Neotropical migratory birds, buntings depend on early successional habitat and are found breeding primarily in upland maritime shrub-scrub habitat. To determine the causes for population declines of shrub-scrub birds, we integrated research from the population, community, and ecosystem (landscape) levels. Two other understory species: the Prairie Warbler (*Dendroica discolor*) and Common Yellowthroat (*Geothlypis trichas*), which overlap in habitat and range with the Painted Bunting, are also declining in the Lower Coastal Plain. By conducting intensive research on reproductive success and survival of these species, as well as those populations that are stable in the region (e.g., White-eyed Vireo, *Vireo griseus*), we will be more likely to determine the causes of population change. Results of this study will be used by managers of federal wildlife refuges, state conservation areas, and local communities, as well as by scientists conducting experimental approaches to help solve this land management/wildlife problem. Cooperators: The University of Georgia, Warnell School of Forest Resources; Georgia Department of Natural Resources, Wildlife Resources Division; The University of Georgia Marine Institute, Sapleo Island, Georgia; U. S. Fish and Wildlife Service, Savannah Coastal National Wildlife Refuges.

Effects of Landscape Changes on the Painted Bunting Population in the Southeastern United States from 1966-1996

J. Michael Meyers

Collaborators: Greg J. Arthaud, Warnell School of Forest Resources, The University of Georgia

The Painted Bunting (*Passerina ciris*) population of the southeastern coastal plain has been declining at approximately 3% annually since the Breeding Bird Survey (BBS) began in 1966. Causes for this decline may be associated with fragmentation of eastern forest habitat into isolated patches, loss or significant alteration of optimum breeding habitat ("source" versus "sink" habitat), and nest parasitism by the Brown-headed Cowbird (*Molothrus ater*). Changes in the amount of the Painted Bunting's breeding habitat and surrounding landscape will be determined from BBS data and by mapping land use and habitat changes for the Painted Bunting at BBS routes and stops from 1960s-1990s. Aerial photographs of 30-40 BBS routes within the eastern range of the Painted Bunting will be obtained for the mid 1960s through 1990s. All BBS stops within these sites that have recorded observations of Painted Bunting in the 1960s, 1970s, 1980s, and 1990s (ca. 10-year intervals) will be located on the aerial photographs using BBS route directions, topographic maps, or ground truth checks. The area of potential bunting habitat (detection distance from the BBS stop) will be calculated using a 50% coefficient of detection, which will be determined for both shrub-scrub and forest habitat of the bunting from ongoing research sites in Georgia and South Carolina. Habitat within 400 m (0.5 km²) of the BBS stop will also be determined. Habitat types will be digitized within these areas (potential bunting habitat and habitat within 400 m of the stop) and will be mapped and classified as optimum, suboptimum, and unsuitable for Painted Buntings. These classes will come from analysis and modeling of population and habitat data for an ongoing study. Data for habitat beyond the area of detection of the bunting (total area of 0.5 km²) will also be used to create realistic landscape maps. These data will be combined with other geographical and biological data (e.g., presence of cowbirds) to create a Geographical Information System (GIS) for selected BBS routes of the Painted Bunting. Data will be used to predict population changes since 1966, based on habitat loss or gain, and to compare with the landscape evaluation of shrub-scrub birds and long term population surveys using regression analysis. Spatial analysis of GIS data should provide insights into causes for decline of the species related to important breeding habitat and biological factors (e.g., increase in cowbirds in the area). If reproductive success and overwinter survival are not limiting the population, then breeding habitat loss may be the primary cause for declines. Results of this study will generate hypotheses for future experimental studies to determine the causes of the population decline of Painted Buntings and other Neotropical migratory birds. Managers will also be able to determine possible land use and conservation practices to increase the bunting population. Cooperators: The University of Georgia, Warnell School of Forest Resources; Florida and Caribbean Science Center.

Status of the Red-Cockaded Woodpecker Population on Billys Island, Okefenokee National Wildlife Refuge

Michael J. Meyers

Collaborator: Sara Aicher

The Okefenokee National Wildlife Refuge has approximately 65 Red-cockaded Woodpecker clusters with more than half of them located on wilderness islands of the interior of the Okefenokee Swamp. Monitoring activities of the woodpecker have been concerned primarily with the location, status, and use of individual nesting trees. Management emphasis has been placed predominantly on the woodpecker clusters located at the periphery of the swamp and outside of the wilderness areas. Billy's Island is one of the largest islands in the refuge and is accessible only by boat or helicopter. To gain information on the status of the Red-cockaded Woodpecker, six woodpecker clusters will be intensively surveyed for nesting success on the island. All young woodpeckers will be color-leg banded prior to fledging and adults may be captured and banded when feasible. Surveys will be conducted to locate and map (GPS) all clusters of woodpeckers on the island. Nesting trees will be identified, inventoried, and mapped (GPS). Avian surveys will be conducted to determine potential competitors for natural cavities. Information and recommendations for future research needs will be provided to the FWS refuge.

Development of Models of Mallard Population Dynamics for Adaptive Harvest Management

James D. Nichols, James E. Hines, William L. Kendall

Adaptive management is an approach to solving the so-called dual control problem of simultaneously managing a population (a goal for the present) and learning about the functional relationships between management actions and population status (in order to achieve future goals). This approach is currently being applied to the annual establishment of mallard hunting regulations in the United States. Research on this topic will range from the development of competing management models, to research on methods for updating associated model probabilities based on a comparison of model predictions with survey results, to work on solutions to problems in optimal stochastic control.

Development of Methods to Estimate Animal Population Dynamics

James D. Nichols, James E. Hines

Changes in animal populations are determined by rates of survival, movement, and reproduction. Because virtually no sampling techniques permit detection of all animals in the sampled area, detection probabilities must be dealt with in any study of population dynamics. This study involves development of statistical models and associated estimators for use in estimating and comparing animal abundance and rates of survival, reproduction, and movement.

Statistical Methods for Species Richness Estimation and Application to Issues of Biotic Integrity

James D. Nichols, James E. Hines, John R. Sauer

Agencies charged with monitoring and managing animals in North America have begun to shift emphasis away from single-species populations to communities and ecosystems. This shift in emphasis requires the development of statistical inference procedures for this level of organization that do not require unreasonable assumptions about the ability to detect individuals of different species. Here, we propose the development of a set of statistical inference procedures to be used in estimating community-level quantities for the purposes of monitoring, managing, and studying animal communities and their dynamics. Indicators of local integrity of ecosystems, including overall species richness, species richness of selected groups of species, and proportion of total species of specific groups can reasonably be developed from survey data. Geographic patterns in these features can be associated with geographic patterns in habitat features to document the observed associations among bird populations and habitat. Also, changes in ecosystem indicators can be modeled in conjunction with changes in habitat to provide insights into the dynamic relationships among these variables.

Developing Models of Black Duck Populations

James D. Nichols

Collaborators: James E. Hines and Mark Miller

The North American Waterfowl Management Plan stated a quantitative population goal of 385,000 black ducks in the [combined] Mississippi and Atlantic Flyways (based on the midwinter inventory [MWI] index) by the year 2000. To assist in attaining this goal, research, banding, and population surveys supported by the Black Duck Joint Venture have been directed toward increasing our understanding both of current black duck population status and of environmental influences on survival and reproduction of the species. Unfortunately, there is still little agreement among researchers regarding the relative importance of harvest, habitat change, and interspecific interactions in causing the decline in black ducks. Although it appears that black duck populations have stabilized (or at least lessened in rate of decline, as shown from indices from the MWI) in association with harvest restrictions, black ducks have not been restored to regions from which they have disappeared, and the range may be continuing to contract. The present research and management program, while providing insights into specific questions, has not provided much insight into the fundamental goal of increasing our understanding of habitat and harvest management.

One method of increasing our understanding of both habitat and harvest management is adaptive resource management. In this procedure, management is used to increase our knowledge of the system. In particular, it is useful in the case where several possible management options exist. By formulating a series of alternative models about the effects of management and the environment on the population, and then by evaluating the consequences of the management action on the population, we can improve our understanding of which model provides the most reasonable description of the system. Adaptive management requires: (1) a clear statement of management objectives (an "objective function"); (2) the ability to select management options (e.g., harvest regulations or habitat manipulations); (3) a set of models that incorporate alternative hypotheses about the population response to the management options and allow prediction of the consequences of management; (4) a monitoring program to provide information on both the current status of the population and the population response to the management; and (5) a measure of uncertainty, that reflects our relative confidence in the alternative models.

Development of the models is a crucial component of adaptive management because it provides a forum for consensus among all participants, shifting emphasis from arguing about a correct model to development of a series of models that incorporate alternative views. The BDJV programs have provided critical information about possible models and population monitoring for black ducks, parts (3) and (4) in the development of an adaptive management program. To advance our understanding of black duck populations, we suggest that the BDJV support the development of models analogous to those used for mid-continent mallard populations. In these models, the sources of information relevant to management are integrated to form a series of reasonable summaries of the yearly cycle of the species. In preparing these models, the various pieces of monitoring information were carefully reviewed, and the relevant pieces were incorporated into the model structure. Because new data sets are now available for assessing black duck population models, and because the relevance of many existing data sets is either unknown or questioned, review of the existing information and integration into a consistent set of models will assist managers in achieving the NAWMP goal.

The NAWMP and the adaptive harvest management working group of the U. S. Fish and Wildlife Service, with the cooperation of the Canadian Wildlife Service, are modeling harvest and environmental impacts on midcontinent mallards; designing actively adaptive approaches for habitat management in the Lower Mississippi & Prairie Pothole Joint Ventures; and considering how impacts can be assessed at multiple geographic scales. The proposed black duck population modeling will cooperate with these efforts to develop model structures in which competing hypotheses about influences of habitat and environmental change on black ducks can be addressed. Information from BDJV-funded research is readily available for model development.

Also, the U. S. Fish and Wildlife Service and the Canadian Wildlife Service are partners in the BDJV, and are involved in the development of the adaptive harvest management initiative. Their recent experience in integrating monitoring programs, modeling, and management will greatly assist the black duck modeling effort.

Completed

White-tailed Deer Fawn Mortality on Mount Desert Island, Maine

Allan O'Connell

Collaborators: Daniel Harrison, Associate Professor of Wildlife Ecology, University of Maine

White-tailed deer (*Odocoileus virginianus*) lack intrinsic mechanisms to maintain populations below K-carrying capacity. Thus, deer populations on a large island where most predators have been extirpated and hunting is prohibited should be limited by food resources. This is not the case on Mount Desert Island (MDI), Maine, where the deer population is stable or declining and is below forage carrying capacity. Studies elsewhere have suggested that low recruitment, associated with high mortality rates of fawns, may contribute to declines in deer populations. Thus, we monitored cause-specific mortality of fawns (n = 29) from birth to 1 year of age during 1991-1995. Annual rate of fawn survival was 0.26. Rate of predator-caused mortality was 0.52, with coyote (*Canis latrans*) predation (n = 8) accounting for at least 47% of mortalities from all causes (n = 17). Mortality rate from drowning was 0.24 (n = 3), and mortality rate associated with deaths from vehicles was 0.14 (n = 3). An index to home-range was not different between a sample of fawns that died prior to 60 days of age (n = 6) and fawns that survived (n = 12). Of fawns radio-collared as neonates, 10 of 14 mortalities occurred during the first 2 months of life. Survival rate from 6 months to 1 year was 0.65; 4 mortalities (2 predation, 2 drowning) were observed during this interval. A subgroup of fawns (n = 11) captured near the Sand Beach had a higher rate of survival to 1 year of age (S = 0.67) than did fawns from all other areas (n = 18, S = 0.00). Recruitment to 1 year of age was lower than has been observed in other northeastern deer populations. Low recruitment associated with multiple causes of fawn mortality may be limiting deer populations in some areas on MDI; however, differential rates of fawn survival throughout MDI may explain an apparent patchy distribution of deer.

Completed

Coyote-Deer Interactions on Mount Desert Island, ME

Daniel Harrison, Associate Professor, Dept. of Wildlife Ecology, Univ. of Maine

Collaborators: Allan O'Connell

Deer populations are increasing in most eastern national parks to the extent where significant negative effects on vegetation structure and species composition are evident. The absence of natural predators is probably a major contributing factor to the unregulated population growth of deer herds in many areas of the east where natural foods are supplemented by food sources supplied by humans. Acadia National Park is an exception; since 1968 there has been no evidence of widespread browsing, despite the insular nature of this park. Declines in utilization of key browse species, high dietary quality relative to mainland populations, and positive correlations among dietary quality relative to mainland populations, and positive correlations among dietary quality, browse availability and browse utilization suggest that deer populations have declined in Acadia National Park and on Mount Desert Island, Maine since 1980. Coyotes, which colonized MDI in the early 1980' are a potential significant predator on deer on MDI; dietary studies suggest that use of deer by coyotes on MDI is high relative to mainland areas. Other deer mortality factors (poaching, roadkills, dog predation) may also be increasing as a result of higher human densities on MDI. In addition, spatial interactions between predators and prey may have profound effects on available habitat for prey species. Studies of spatial relationships between white-tailed deer and a canid predator (wolves) concluded that this aspect of deer-predator interactions may be significant. This study will utilize radio-telemetry to estimate cause specific mortality rates for deer, degree of spatial overlap among radio-collared coyote and deer social groups, and the extent of shared use of park and non-park lands by deer on MDI. Deer mortality rates will be incorporated into a stochastic simulation model to assess the influence of natural predation and human-influenced mortality on deer population dynamics on MDI.

**Technical Assistance to U.S. Fish and Wildlife Service Region 1:
Mariana Archipelago Rescue and Survey (MARS)**

Glenn Olsen

We know from the natural histories of Hawaii and Guam that extinction rates climb when man enters an island environment. The introduction of brown tree snakes on Guam has been especially devastating on the avifauna of that island. The spread of the brown tree snake to other islands is a real possibility. Our goal is to identify those species unique to the island and assess their ability to be successfully brought into captivity for potential breeding programs should this become necessary. To do so we have over the last several years brought birds of three species into captivity, and, in one case, successfully returned birds to the wild.

Species Decline: Contaminants and Other Contributing Factors

Oliver H. Pattee, Barnett A. Rattner, Ronald Eisler

Members of over 1,200 taxa have been listed as Threatened or Endangered, and over 4,000 additional organisms have been identified for listing as Candidate Species or Species of Concern. Both naturally-occurring and human activities (e.g., environmental contaminants and pollution) have been shown to be a major factor in the decline of many species. The purpose of this project is to develop a database that lists and ranks the presumed causes of these declines, with special emphasis on contaminants and pollutant-related situations. This will be accomplished by reviewing the U. S. Fish and Wildlife Service's approved recovery plans for the reasons which lead to listing and for the information and management actions needed to bring about recovery. These factors will be itemized, cross-referenced, enumerated, and categorically ranked (e.g., phylogenetic, anthropogenic, habitat, contaminant). Particular attention will be given to factors which impact numerous species or are particularly detrimental to specific taxonomic groups. Listing packages will serve as a secondary source of information. Summary data and tabular findings will be made available to clients through both an NBS publication and a readily-accessible computer database. The potential use of this information includes facilitating reviews of Section 7 consultations and Environmental Impact Statements, reviewing permit applications, conducting environmental contaminant risk assessments, identifying specific data gaps and research needs, selecting potential management actions, and establishing priorities for broad-based research on limiting factors applicable to groups of species rather than the current species-by-species approach.

Field Validation Study of a Constructed Wetland System for Wastewater Treatment in the Patuxent River Watershed

Matthew C. Perry

A 6-acre tertiary wastewater treatment facility consisting of seven water storage pools, 14 treatment cells, and a constructed forested wetland was constructed in 1993-94 as part of the National Wildlife Visitor Center at Patuxent Research Refuge. Eight of the cells were planted with a variety of broad- and narrow-leaved emergent plants and six of the cells were planted with three species of woody plants. Capacity of the system is 13,800 gallons per day.

The system is unique in that it is the first known system that uses a combination of emergent and woody plants in treatment cells in combination with a constructed forested wetland to remove nutrients from wastewater. The system was designed to facilitate research on nutrient removal from wastewater by plants. Current studies in the 14 cells are determining the survival and growth of the various herbaceous and woody transplants and the volunteer plants. Based on percent ground cover, arrowhead (*Sagittaria latifolia*) was the most successful of the broad-leaved emergents and river bullrush (*Scirpus fluviatilis*) of the narrow-leaved emergent plants.

Based on percent survival, buttonbush (*Cephalanthus occidentalis*) was the most successful among the woody plants, although overall, all species of woody plants had high mortality. Nutrients (nitrate and phosphate) in water samples declined as water moved through the system. Odonate (dragonfly) surveys are conducted at the upper pools and emergent cells to see if differences can be detected in use of the pools or cells by the dragonflies based on nutrient levels in the water.

Optimal Strategies for Biodiversity Within a Powerline Right-of-Way

Matthew C. Perry

Five habitat management techniques replicated 4-6 times in sections along the new 5.3 mile-long BGE powerline right-of-way located at Patuxent Wildlife Research Center are being evaluated in regard to their use by wildlife. Techniques include: complete mow, strip mow, low volume foliar spray, selective basal spray, and tree topping. Three replications of each of the five management techniques were randomly selected in right-of-way areas that had similar habitat on both sides of the management sections. Vegetational surveys conducted in randomly selected 25 X 25 meter plots in each treatment area will determine plant species composition. The value of these plants as food and cover for wildlife will be used to evaluate each treatment. Bird density is being determined by line transect sampling established near the center of the right-of-way. Occurrence of mammals, reptiles, and amphibians in each habitat type is being determined by traditional sampling methods, including live trapping, sand plot track counts, and drift fences with pitfalls and funnel traps. Wildlife observations and kills by hunters that regularly use the power line right-of-way will be collected on survey cards and compared with results from other techniques. The combined use of each habitat by wildlife will be compared to the cost (work-hours, equipment, materials) to maintain the various habitats. Data from this study will be of value to powerline right-of-way managers and other land managers concerned with providing optimal habitat for floral and faunal biological diversity.

Evaluation of Forested Wetlands Constructed for Mitigation in Comparison to Natural Systems

Matthew C. Perry

Intensive research on six constructed forested wetlands in Central Maryland was conducted in 1993-1996 to determine success of these habitats as functional forested wetlands for wildlife. Areas studied ranged in size from 2 to 35 acres and were constructed by private companies under contract with three mitigation agencies. Adjacent natural forested wetlands were used as reference sites where similar data were collected. Based on data from the first four years of this study it appears that it will take 35-50 years before these areas have

forested wetland vegetation and wildlife similar to that found on mature forested wetlands. This long-time period is based on the high mortality and slow growth of nursery-stock trees and shrubs transplanted on the areas. Mortality and slow growth resulted mostly from excessive surface water on the sites. The level of ground water did not appear to be a factor in regard to transplant mortality. Green ash was the woody transplant species that had the least mortality. Sampling of vegetative ground cover with one-meter square quadrats showed the predominance of grasses and herbs. Numerous bird species were recorded feeding, resting, and nesting during biweekly surveys, and many species were associated with the open water impoundments near the forested wetlands or with ephemeral surface water areas. Species of small mammals on constructed forested wetlands were those species most typical of meadow habitats. Numerous amphibians were caught on both constructed and reference sites and there was range overlap of most species for the two sites. Wood frogs and salamanders were uncommon or absent on the constructed sites, and probably represent the best wildlife species to evaluate the maturation of a forested wetland from a wildlife perspective.

Enhancement of Wildlife Habitat with the Use of Compost Soil Amendments

Matthew C. Perry

Increased interest in wildlife biodiversity and the restoration of wildlife habitats and populations, makes it appropriate to study habitat enhancement techniques at Patuxent Wildlife Research Center (Patuxent). Several areas of Patuxent have been degraded by human activities and provide excellent study sites. The primary objective of this study is to compare two compost materials (COMPRO and LEAFGRO) to enhance wildlife habitats, while maintaining optimal floral and faunal biodiversity. A secondary objective is to determine optimal techniques to apply compost materials to large wildlife habitat areas (e.g., power line rights-of-way) to improve soil quality that will result in improved plant and invertebrate biodiversity. This study is being conducted at two sites that were degraded by previous military and farming operations. Two 50 x 100 meter sections of each site were plowed and disked in April and again in May 1996. The blocks were gridded into 8, 25 X 25 meter square plots (0.06 hectares) using PVC stakes in each corner. The two soil treatments and two types of controls were randomly assigned to the 8 plots and replicated two times. Control plots received no amendments and were of two types: one that was planted with a warm season grass mixture and one that was not planted. Plots receiving compost were also planted with a warm season grass mixture. The COMPRO and LEAFGRO were applied with a modified manure spreader and disked into the soil to a depth of 3 inches. Sampling for invertebrates with a sweep net was conducted twice during each month starting in October 1997 when vegetation was mature. In addition, a five-gallon bucket (pit-fall trap) was placed in the soil in the middle of each plot level with ground surface. Pit-fall traps were opened for five days during the middle part of each month starting in October 1996. All invertebrates were identified in the field. Pit-fall traps were also used to capture small rodents, insectivores, and amphibians that were using the areas. One Sherman live trap was placed in each plot and trapping for small mammals was conducted during the five-day period that pit-fall trapping was conducted. Bird surveys were conducted in October-November 1997. Data from this study will be used by land managers to enhance habitat for wildlife on public and private land.

Benthic Invertebrate Response to Impoundment Management

Matthew C. Perry

Increased concern for wildlife (especially shorebird) populations in recent years has prompted several eastern refuges to manage impoundments to make invertebrates more numerous and available for shorebirds and other wildlife. USGS Patuxent Wildlife Research Center is responding to the need for more information of impoundment management by conducting new research on this subject. Benthic invertebrates will be sampled at Patuxent and other refuges in the mid-Atlantic coastal area to correlate invertebrate density and richness with management activities. Selected invertebrates, such as chironomids (midge flies), will be used as indicators of the effect of management techniques. Overall objective will be to increase invertebrate biomass, while not decreasing diversity in benthic invertebrate communities. Specific objectives include (1) evaluating the timing and rate of spring drawdown, (2) evaluating the effect of summer drawdown, and (3) evaluating the importance of coarse particulate organic matter in regard to invertebrate populations. Management techniques will be tested in 15 impoundments (2-16 acres in size) and in 18 experimental pools (0.06 acres each) at Patuxent to determine which techniques optimize chironomid production and survival. When optimal management techniques are determined, more extensive monitoring will be established for the entire Region 5 area of the USFWS. This information will improve managers' understanding of the effects of moist-soil management on benthic invertebrates in addition to vegetative communities.

Coordination of the North American Breeding Bird Survey

Bruce Peterjohn and Keith Pardieck

The North American Breeding Bird Survey (BBS) was established in 1966 to monitor the status and trends of all species of birds breeding in North America. The status of bird populations can change very rapidly, a result of diverse factors including habitat changes in breeding and wintering ranges, adverse weather conditions, management activities, poor reproductive success, and excessive mortality during migrations. The BBS monitors these changes by providing current trend estimates to promote our knowledge of the overall health of regional wildlife communities and the ecosystems they inhabit. These data also allow resource managers to prioritize their management activities on the basis of recent, accurate trend information. The BBS is interested in the development of improved methods for analyzing population trend data, to enhance the reliability of its trend estimates and utility for resource managers. As interest in the survey continues to grow each year, improving the efficiency of the daily operations is essential for the continued operation and success of the BBS. The BBS will continue to improve its data processing and management operations, including the use of scannable forms and electronic data submission, to meet these needs.

Development of a National Bird Monitoring Data Center

Bruce Peterjohn

Although there are dozens of ongoing programs in North America that attempt to monitor bird populations, information varies greatly in quality and there is no centralized mechanism for accessing or distributing all the available information. One especially important database, related in particular to migratory game bird monitoring programs, is the bird-banding database. This database is presently difficult to use, because it is hierarchically structured, lending itself to batch jobs and high labor and maintenance costs. The overall goal of this project is to improve the migratory bird management capabilities of resource management agencies by streamlining operational systems for management of bird population data and by making all the available information maximally accessible to users. Key objectives in meeting the goal are (1) to redesign and re-engineer the Bird-Banding Laboratory so that the great majority of data import and export functions are electronic and a new client server, relational database is accessible by users through the Internet; (2) to build an integrated network of North American bird population monitoring programs, linked through an electronic center containing relational databases also accessible through the Internet, along with analytical software packages for the convenience of the clients. Initial emphasis will be on the Breeding Bird Survey, Christmas Bird Count, colonial waterbird databases, and songbird point count databases. Incorporation of databases maintained by outside organizations into the data center will be achieved through a series of partnership agreements entailing varying levels of data management support by Patuxent, depending upon the data management capabilities of the partner. Support will be provided for development of monitoring programs for taxa not presently covered and for improvement of presently deficient programs. The primary Federal agency in this project is the U.S. Fish and Wildlife Service.

Relationship Among Persistent Contaminant Burdens and Reproductive Parameters in Mink from Apostle Island National Lakeshore, Lake Superior and Green Bay, Lake Michigan

Barnett A. Rattner, Mark J. Melancon

Mink (*Mustela vison*) are known to be extremely sensitive to PCBs, dioxins and furans. Despite the extensive data base on contaminant-effects generated with captive mink, little is known of such effects in free-ranging mink other than information on exposure (residue burdens). This study is part of a cooperative project with Wisconsin DNR and Southern Illinois University, that seeks to assist in the development, application, and evaluation of biochemical and physiological methods as part of the health assessment of free-ranging mink. In 1996, activities of the co-investigators involved with this project focused upon population estimation and survey procedures, evaluation of live-trapping and radiotelemetry techniques, and development of Habitat Suitability Indices and Habitat Evaluation Procedures. In 1997, mink of 5 different reproductive states/age categories [i.e., adult male mink, N=10; anestrus females, N=10; reproductively-active (estrus and gravid) females, N=20; male kits, N=10; female kits; N = 10] will be live-trapped from 3 study sites. Blood samples will be analyzed for cytology, serum chemistry and hormone concentrations; tissues sub-samples will be histopathologically examined; liver and reproductive organs will be analyzed for cytochrome P450 and steroid hormone receptor density and affinity; and kidney and liver sub-samples will be analyzed for various contaminants. Biological responses (morphological, blood chemistry, histopathological, steroid receptor) will be categorized by age, sex, reproductive state, study site and degree of contamination (pollutant concentrations, P450 induction). Effects of contaminants on these indicators of mink health, sexual differentiation and fertility of adults will be evaluated by parametric statistical analysis.

Applying a Bioassessment and Monitoring Framework for Public Lands and Trust Resources Along the Atlantic Coast

Barnett A. Rattner

Retrospective contaminant and environmental quality information are being assembled for terrestrial species residing in estuaries along the Atlantic Coast (Gulf of Maine through South Florida). Published and gray literature are being summarized on the morphology, status in estuaries (resident, migrant, breeders), abundance and range, site fidelity, ease of census, feeding habits, contaminant exposure, and contaminant effect data, for 20 terrestrial species (1 reptile, 18 birds, 2 mammals) commonly found in Atlantic estuaries. These data will be analyzed to characterize the condition, relative sensitivity and suitability of these species as sentinels of contamination and pollution in estuaries. To date, draft characterizations have been completed for seventeen species (3 to 18 single pages/species). It is envisioned that this information will be made publicly available via Internet. Data for these and other Atlantic coast terrestrial vertebrate species are also being entered into a 96-field database organized by species, geo-referenced sampling location, date of sample collection, contaminant exposure/effects, and reference source. A pilot database was initially assembled in tabular and map form for the state of Maine. Data for over 3000 geo-referenced sites between Maine and Florida have since been entered into the data base. This information will be made available in tabular and map form. Ultimately, a risk assessment will be conducted to identify and characterize contaminants and other terrestrial vertebrate stressors in these estuaries. Specific assessment and measurement endpoints will be used in this exercise to rank and prioritize estuarine ecosystems that are potentially at risk, and to focus future Patuxent biological monitoring and research partnerships.

Contaminant-Related Activities and Synoptic Reviews in Support of Client Agencies in the Department of the Interior

Barnett A. Rattner

The Interagency Testing Committee (ITC) of the Toxic Substances Control Act (TSCA) was enacted in 1976 as an independent advisory group to the Administrator of the U.S. EPA. The ITC prioritizes and coordinates the testing of TSCA-regulable chemicals, recommends chemicals for testing to the Administrator in a Priority Testing List (PTL), publishes semi-annual reports in the Federal Register addressed to the EPA Administrator that contain the PTL, reviews toxicological data submissions from chemical manufacturers, and develops dossiers on chemicals of concern. In the 41st report to the Administrator of the EPA, the ITC 'recommended' a total of 29 alkylphenols, alkylphenol ethoxylates, and polyalkylphenols, because of data needs on (i) chemical composition (major components and impurities), (ii) environmental fate of components and impurities, and (iii) health and ecological effects, including toxicokinetics and endocrine-modulating effects. By law this action requires that all manufacturers and importers of these chemicals submit production and exposure data, and results of health and safety testing for our review. Efforts of the U.S. Environmental Protection Agency's Endocrine Disruptor Screening and Testing Committee are nearing completion on the development of a prioritizing and ranking scheme to address the endocrine disrupting potential of approximately 80,000 chemicals in commerce. Collaborative efforts are well underway with Dr. Richard Shore of the Institute of Terrestrial Ecology, Monks Wood, England, to coedit a book entitled Ecotoxicology of Wild Mammals that will provide a extensive summary information for contaminant risk assessments conducted by natural resource managers.

**Effects of Organochlorine Contaminants on Reproductive Success
of Black-Crowned Night-Herons (*Nycticorax nycticorax*)
Nesting in Baltimore Harbor, Maryland**

Barnett Rattner

Recent findings of cytochrome P450 induction in pipping black-crowned night-heron embryos, associated with exposure to total PCBs and arylhydrocarbon receptor-active PCB congeners, and the remarkable accumulation of rates of total PCBs in nestling herons from Baltimore Harbor, may foreshadow effects at higher levels of biological organization, including the population level. With the assistance of cooperators (Chesapeake Bay Field Office, Fish and Wildlife Service; New York State Department of Health), a "sample egg" will be collected from each of many black-crown night-heron nests at the Baltimore Harbor colony in the spring of 1998. Hatching and nesting success of the remaining eggs in each nest, and the concentration of contaminants in the "sample egg", will be statistically evaluated using various curve fitting procedures to determine if, and at what threshold concentration, contaminant exposure is adversely affecting reproduction. These data will determine if organochlorine contaminant exposure (total polychlorinated biphenyls, arylhydrocarbon receptor-active PCB congeners, and chlorinated pesticides) is resulting in reproductive impairment of the black-crowned night-heron within Baltimore Harbor. The results of this project specifically address Chesapeake Bay Program needs including monitoring pollution in a Region of Concern, and documentation of the impact of pollutants on living resources.

Technical Assistance to the Fish and Wildlife Service on Alternative Shot

Barnett A. Rattner

Coincident with the prohibition of toxic lead shot for the hunting waterfowl in the U.S., procedures for registration of candidate nontoxic shot were instituted (50 CFR Part 20, section 20.134; 1986). These test guidelines focused on determining whether ingestion of the candidate shot or shot coating posed a significant hazard to waterfowl compared to lead and steel shot. Over the past decade, the safety of several candidate shot (e.g., bismuth, tungsten) and shot coatings (e.g., zinc, tin) have been evaluated. Unfortunately, the original registration guidelines do not address potential toxic effects of candidate materials on biota other than waterfowl (e.g., invertebrates, fish, amphibians, reptiles, mammals), or their supporting habitats. Accordingly, a new tiered testing protocol (FR vol. 61 no. 18 2470-2477), with a much broader ecological perspective, was developed and is about to be implemented. This new protocol for evaluation of candidate materials utilizes an ecological risk assessment approach. It is scientifically more robust and also less burdensome for those attempting to develop and register nontoxic shot. Attempts are underway to harmonize these new testing guidelines internationally.

New candidate shot and shot coatings for the hunting of waterfowl and coots continue to be developed by various manufacturers. This project evaluates toxicological data submitted by manufacturers in order to assess and insure the safety of these candidate materials to "nontarget organisms" and their supporting habitat.

Extent and Distribution of private Land Managed as Winter Habitat for Waterfowl in the Mississippi Alluvial Valley

Kenneth J. Reinecke

Collaborator: Richard M. Kaminski

Management of private lands as winter habitat for waterfowl in the Mississippi Alluvial Valley is thought to be important in maintaining populations, but the extent of this effort has never been determined. We cooperated with staff from Mississippi State University to conduct aerial sample surveys in the Mississippi Alluvial Valley during 3 winters (1992-93 through 1994-95) to estimate the area of private land flooded to benefit waterfowl. The resulting estimates were consistent among years, and indicated that 350,000 to 400,000 acres (SE = 35,000) of private land are flooded each winter in the Mississippi Alluvial Valley to attract waterfowl. The largest area of private land managed for waterfowl was in eastern Arkansas (>200,000 acres), and the smallest area was in southeastern Missouri (20,000 acres). Experiments also were conducted to determine the ability of aerial observers to correctly classify and estimate the size of habitat units. Results from the latter studies suggested that these sources of error were relatively small (0-10%), and that the survey design was robust with respect to potential biases. Results are being used by private, state, and federal wildlife managers to implement the North American Waterfowl Management Plan in the Lower Mississippi Valley.

Effects of Flooding Rice Fields during Winter on Rice-Soybean Production Systems

Kenneth J. Reinecke

Collaborators: John F. Robinson and Tony E. Windham

The welfare of many waterfowl species depends on the extent to which their habitat requirements can be integrated with agricultural activities. In the Lower Mississippi Valley, many farmers grow rice and soybeans in rotation on irrigated fields, and some of these farmers believe that farm income increases when fields are flooded during winter (i.e., the non-growing season). Flooding fields in winter also provides public benefits, such as habitat for wintering waterfowl and improvements in water quality. With help from the University of Arkansas Rice Research and Extension Center, we initiated experiments in 1996 to determine the effects of winter flooding of rice fields on the production costs and yield of subsequent soybean crops. Treatments in the initial experiment conducted during winter 1996 and summer 1997 will include 3 methods of managing rice straw after autumn harvest (no treatment, disking, rolling), 3 approaches to management of water on rice fields in winter (not flooded, flooded by pumping, flooded by rainfall), 2 planting methods for the spring soybean crop (conventional and no-till), and 2 water management systems for soybean production (irrigation and dry-farming). The principal data collected will be costs of winter water management on rice fields, costs of producing soybeans, and the yields and economic value of subsequent soybean crops. Further experiments will be conducted during 1997-98 and 1998-99, building on results obtained in preceding years. If winter flooding is beneficial with respect to farm income, state and federal agencies implementing the North American Waterfowl Management Plan may be able to encourage additional landowners to provide waterfowl habitat on crop lands in the Mississippi Alluvial Valley, where more than 3,000,000 acres of rice are planted each year.

**Technical Assistance to the Fish and Wildlife Service,
Lower Mississippi Valley Joint Venture**

Kenneth J. Reinecke

Collaborator: Daniel J. Twedt

The Mississippi Valley Research Group of Patuxent Wildlife Research Center and the Lower Mississippi Valley Joint Venture of Fish and Wildlife Service Region 4 have been co-located since inception and share interests in migratory bird research and conservation. The Joint Venture is committed to landscape habitat management programs based on sound science. As such, the Joint Venture has sought technical input from BRD staff and other scientists in formulating population and habitat objectives and in evaluating management programs. This task project addresses the need of the Joint Venture for continuing technical assistance in a way that benefits the Fish and Wildlife Service and BRD. Scientists from the Mississippi Valley Research Group will provide results of ongoing research on waterfowl and migratory forest birds to the Joint Venture, review proposed monitoring and evaluation plans, and share costs of acquiring computer technologies (e.g., internet access and mass storage) and statistical and spatial databases (e.g., satellite imagery and aerial photography) that neither organization alone could afford. The principal benefits of continued cooperation to the Joint Venture will be timely access to new and existing research data, and increased efficiency and effectiveness of management programs. Benefits to BRD will include access to computing facilities and datasets needed for research projects, and opportunities to obtain funding for research addressing priority management issues and provide input regarding identification of future bureau information needs.

**Curation of the North American Vertebrate Collections,
Smithsonian Institution**

Robert P. Reynolds

The U.S. Geological Survey's Curatorial Project based at the Smithsonian Institution has curatorial responsibility for approximately 900,000 scientific specimens and the associated data for North American amphibians, reptiles, birds, and mammals housed at the National Museum of Natural History. These systematic collections and accompanying specimen records help serve as the basis for cataloguing the diversity of these vertebrate groups, understanding their evolutionary relationships, and characterizing their past and present distributions. Activities of the Curatorial Project include collecting specimens, identification of specimens, processing and cataloguing incoming specimens, computer capture of specimen data, routine care of collections, curation of selected portions of the collections, processing loans of scientific specimens to researchers at other institutions, and handling information and identification requests for Federal and State agencies and University researchers. Special emphasis is placed on the development of improved specimen conservation techniques, attention to current taxonomy and resultant specimen arrangement, improved effectiveness of data access, management, and information retrieval, and facilitating the use of specimens and data for educational and scientific purposes. Members of the national and international scientific communities are served as a direct result of our activities of providing identifications, well curated collections, specimen data, information, and research access to the collections and associated records in the care of this program.

Completed

Feasibility of Using Amphibians as Biological Indicators in the Study of Acid Mine Drainage of Streams and Associated Aquatic Habitats

Thomas H. Fritts, Robert P. Reynolds

Amphibians constitute the most common of vertebrates in eastern deciduous forest habitats and occupy a variety of associations with streams and other aquatic habitats susceptible to environmental perturbations. The potential for use of amphibians as biological indicators of environmental quality related to acid mine drainage is heightened by their associations with aquatic habitats, the diversity of species and life history cycles, abundances, and prominence in scientific collections in the care of the Biological Survey Program and housed at the National Museum of Natural History. By seeking geographic concordance between known sites of acid mine contamination, and historical samples of salamanders within the comprehensive collections originally assembled by Dr. Richard Highton from the mid 1950s through the late 1980s, we will attempt to establish baseline evidence for evaluating changes due to acidification of stream systems, identify sites for preliminary sampling of the distribution and abundance of salamanders and their species composition relative to acid mine discharges, and develop a preliminary assessment of the value of amphibian studies in guiding acid mine drainage management and restoration efforts. We will overlay detailed ecological data based on precise specimen and locality records with the stream quality data available from previous acid mine drainage research and attempt to interpret the potential of this system for future studies in the eastern Appalachian Region.

Application of Satellite Imagery to the Conservation of Neotropical Migrants in Guatemala

Chandler S. Robbins, Barbara A. Dowell

FUNDAECO designed a biosphere reserve at Cerro San Gil and purchased with donated funds more than 4,000 hectares of the mountain. In November 1996, based largely on the rich avian diversity we had documented for the area, the Guatemalan legislature declared Cerro San Gil a National Protected Area, the largest National Protected Area (48,000 hectares) in Guatemala. In 1997 we continued to use this reserve as a research and demonstration area in collaboration with FUNDAECO biologists and also used it for training Guatemalan college students in monitoring methods and bird identification. A pilot monitoring program including a modified roadside Breeding Bird Survey that we initiated in April 1996 in the Department of Izabal, which includes Cerro San Gil, was surveyed again in April 1997. This program revealed that many neotropical migrants that winter in Izabal District do not occur in the core area of the reserve, but use wetlands, streamside habitats, agricultural lands, and other habitats that are not protected. This led FUNDAECO to initiate an innovative program to secure cooperation of land owners and land managers to conserve and protect examples of these important habitats through conservation easements and other methods.

Preliminary results of this research were presented at Nature Conservancy workshops in Panama and Belize and to other conservation groups, and distribution maps for 40 bird species plotted on a satellite imagery map are displayed on the USGS Patuxent home page. Three papers for peer reviewed journals are in various stages of preparation.

Impacts of Land Use Changes on Migratory Nongame Bird Populations

Chandler S. Robbins, Barbara A. Dowell

Belize is a major wintering area for neotropical migrant landbirds. Belize also has the highest percentage of its tropical forest intact of any Central American country. However, the human population of Belize is rapidly expanding, and forested lands are rapidly being converted to agriculture. Many species of neotropical migrants can winter successfully in altered habitats, but others are more specific in their requirements and depend on the native forest for winter survival. This study was designed to sample winter bird populations in all the major natural and altered habitats of Belize using mist netting and point counts and also to measure the number of acres of each habitat (using a natural vegetation map and satellite imagery), and to map the distribution and relative abundance of each bird species throughout the country. By determining rates of habitat change from satellite imagery in different years, projections can be made regarding threats to species that are habitat specific. Partners include Belize Ministry of Natural Resources, Blue Creek Research Station, Canadian Wildlife Service, Light Hawk, Estación de Biología "Los Tuxtlas", Manomet Bird Observatory, Maryland Ornithological Society, Parrots' Wood Biological Station, Programme for Belize, University of Maine, Wildlife Conservational International.

Design and Test a Long-Term Coastal Monitoring Program at Cape Cod National Seashore with Application to Other Coastal Units of the National Park Service

Charles T. Roman, James R. Allen, John W. Portnoy

The National Park Service has identified Cape Cod National Seashore as a prototype monitoring park for the Atlantic and Gulf coast biogeographic region. A long-term ecosystem program is necessary to inform park management of ecosystem changes, to provide scientifically-based evaluations and interpretations of observed changes, and to support development of appropriate solutions to protect ecosystems. The purpose of this study is to design and test scientifically-defensible monitoring protocols for long-term application by Cape Cod National Seashore and other seashore parks. Ecosystems to focus on in the program will include ocean and estuarine shorelines, freshwater wetlands and ponds, estuaries, maritime forests and heathlands.

Groundwater Withdrawal from Municipal Wellfields: Ecological Effects on Aquatic Resources of Cape Cod National Seashore

Charles T. Roman, John W. Portnoy

Collaborators: Thomas Cambareri, Hydrologist, Cape Cod Commission, MA; Robert Sobczak, Hydrologist, Cape Cod Commission, MA

The fundamental objective of this research is to determine the ecological impact of groundwater withdrawal on Cape Cod National Seashore wetland habitats. Proposals are currently being considered for municipal groundwater withdrawal from sites adjacent to the Seashore. With groundwater extraction it is expected that freshwater discharge will be reduced to wetlands and water table levels will be decreased. These hydrological changes will likely result in wetland sediment chemistry and vegetation changes. This study is employing gradient analysis with ultimate development of a process-response model aimed at predicting the response of wetland habitats to altered hydrologic regimes.

Kettle Pond Macrophytes at Cape Cod National Seashore: Species Composition and Mapping

Charles T. Roman, John W. Portnoy

Collaborators: Nels Barrett, The Nature Conservancy, Middletown, CT

At present there is a gradient of kettle ponds from undeveloped oligotrophic ponds to ponds with developed shorelines and tending toward eutrophic conditions. Macrophytes along the littoral pond margins may serve as valuable indicators of nutrient loading to ponds. The purpose of this study is to inventory the species composition of macrophytes along pond shorelines, to map shoreline vegetation, to evaluate relationships between vegetation and environmental variables, and to establish long term monitoring protocols to detect changes in pond flora in response to nutrient enrichment.

Ecological Implications of Shellfish Aquaculture in Cape Cod National Seashore and Vicinity

Charles T. Roman

Collaborators: Donald G. Webb, University of Rhode Island,
Candace A. Oviatt, University of Rhode Island

As interest increases in the use of natural habitat for quahog (*Mercenaria mercenaria*) aquaculture purposes within the boundaries of Cape Cod National Seashore, research on the implications of aquacultural practices on estuarine ecosystems is needed. This study will review the practices and extent of molluscan aquaculture within the Seashore and will use a controlled field experimental approach to determine how existing quahog grow out facilities affect benthic communities and sediment properties. The study will predict the impact (if any) of quahog aquaculture on existing intertidal areas of the Seashore and provide insights into long-term, system-wide effects.

Completed

Primary Productivity of Somes Sound, Acadia National Park, Maine

Charles T. Roman

Collaborators: Peter H. Doering, South Florida Water Management District, W. Palm Beach, FL

Somes Sound, a fjord-type estuary associated with Acadia National Park (Maine), has been the focus of water quality baseline studies since 1991. Fjords can often experience strong stratification and subsequent low dissolved oxygen levels in bottom waters -- a fate that can be accelerated with high rates of primary production and the contribution of organic matter to bottom waters. The purpose of this study is to establish a baseline of water column primary production in the Sound. Primary production is an initial response process to increased nutrient loading. It is expected that the method developed and data analyses procedures can be readily transferred to other National park estuarine sites.

Denitrification in a Cape Cod National Seashore Estuary and Relationships to Groundwater Discharge

Collaborators: Barbara L. Nowicki and Candace A. Oviatt, University of Rhode Island;
John W. Portnoy, Charles T. Roman

Groundwater contaminated by septic systems and other non-point sources may be a principal source of nutrients to the shallow coastal embayments of the northeast. At Cape Cod National Seashore's Nauset Marsh there is convincing evidence that nitrate levels are high in the groundwater associated with the developed portion of the Nauset watershed; however, there is little known about the fate of these groundwater-borne nutrients once they reach the sediment-water interface in coastal areas. The purpose of this project is to determine whether denitrification represents a significant removal mechanism for groundwater derived nitrogen and to describe the role of nitrate loading rates, sediment type, and season in controlling denitrification rates in the nearshore groundwater discharge zone.

Technical Assistance to the National Park Service - Coastal Ecology

Charles T. Roman

Collaborator: Martha Nielsen

For over three decades estuaries have been the focus of extensive research because of their biological diversity, high productivity, and intense development pressure related to development and commerce within the coastal zone worldwide. A classic volume, published by the American Association for the Advancement of Science (Lauff 1967), contained benchmark research papers describing the evolution of estuaries and the physical, chemical, geological and ecological processes that define the functioning of estuaries. This volume was a driving force toward setting the global estuarine research agenda for several decades. As we approach a new century, it is time for another critical evaluation of estuarine research. This new volume, "The State of Our Estuaries," will be an invited volume generated from the recent 1997 International Conference of the Estuarine Research Federation. The edited book will contain a synthesis and review of physical, geological, chemical and biological processes that define estuaries worldwide. Moreover, the volume will provide a critical interpretation of the research and management issues that will confront estuarine scientists and resource specialists for the next several decades, and thus, will help guide public and private sector estuarine research and policy programs.

**Procedures for Collection, Analysis, and Display of Data Collected
at Several Geographic Scales: Migratory Bird Research
at the Patuxent Wildlife Research Center**

John R. Sauer

In this study, we are developing procedures for summary and display of information from surveys that collect information at several geographic scales. We are investigating methods for entering data and providing summarized results and other information over Internet. We will also evaluate procedures for monitoring based on specific objectives. Because of ongoing needs for development of multi-scale monitoring programs for birds in the U. S. Fish and Wildlife Service, bird surveys will be emphasized in the development of the procedures. Information from work on small mammal monitoring at the USGS Patuxent Research Refuge will be used to address mammal monitoring on refuges. And, our collaborative work with the BRD groups involved with monitoring amphibians, butterflies, and other taxa will be considered as a resource for developing refuge monitoring for other taxa.

**Development of within-route Information from the
North American Breeding Bird Survey**

John R. Sauer

The North American Breeding Bird Survey (BBS) is a critical source of information on population change in North American birds. The BBS is composed of over 4,000 roadside survey routes, each of which contains information from 50 count locations (called stops). In this project, we are digitizing BBS route paths, to assist agencies and users of BBS data that use GIS technologies that allow for summary of survey data at many different scales. Tiger data files produced by the Department of Commerce will be used as a primary source of information for digitizing route locations. These data files provide arc coverages of roads in the United States. When necessary, additional arcs will be added to identify dirt roads and other paths not available in the Tiger files. Using these data, arcs will be selected that represent the path of the BBS survey route from starting to finishing point. This information will be available as arc coverages in Arc/Info GIS.

**The Wisconsin Frog and Toad Survey:
Analysis, Standardization, and Access**

John R. Sauer

Evidence of declines in amphibian populations has created a critical need for development of procedures for monitoring population change of amphibian species, regionally and on Federal lands. The Wisconsin Department of Natural Resources (DNR) developed a regional survey in 1981, and has maintained a database of survey results. Because of the importance of these data in both documenting population changes and as pilot data for other surveys, a need exists to use modern procedures for analysis of the data, to critically evaluate possible sources of bias in survey results associated with sampling procedures, and to make the data and results accessible via Internet. We propose to use new analytical methods for assessing population change on the Wisconsin survey data. In this analysis, we will evaluate possible bias associated with site selection, which will complement a proposed field study on site selection bias to be conducted by the DNR. In collaboration with the DNR, we will also develop an Internet Home Page for the survey, in which users will be able to access survey results, conduct analyses, and gain access to data. The analyses and Home Page should be of use to land managers, biologists, and the public, both by developing a new tool for analysis and by providing increased access to information from this significant data set.

Assessing Reconstructed Depressional Wetlands in the Mid-Atlantic States

Don Sparling

Many state and federal agencies which manage or regulate wetlands require an objective, repeatable, standardized method of assessing wetland health. Several methods have been developed over the last 10 years and the one currently in vogue is the hydrogeomorphic approach which assesses wetland functions but not health. One method, the Index of Biological Integrity, has been used successfully on streams and may prove to be a valuable tool for assessing wetland health from an ecological perspective. This study is a cooperative effort with the Wetland Sciences Institute of the U.S.D.A. Natural Resources Conservation Service, and the Environmental Protection Agency, in association with the Chesapeake Bay Field Office of the U.S. Fish and Wildlife Service, and the Chesapeake Wildlife Heritage to develop monitoring protocols for constructed depressional (seasonal to semi-permanent) wetlands in the Mid-Atlantic States. Each wetland will be monitored for water chemistry, aquatic macrophytes, macroinvertebrates, fish, amphibians, birds, and mammals. Separate IBI's will be constructed for each of the major taxonomic groups. These IBI's will consist of metrics based on such things as species richness and percent composition of various trophic levels, and organism health. The metrics will be verified using a set of reference wetlands in the Eastern Shore of Maryland.

Hazard Assessment of a Contaminated Wetland to Amphibians

Don Sparling

A natural wetland located at the Quantico Marine Base, Quantico, VA is adjacent to a landfill which is being capped and cleaned up. This wetland is known to be contaminated with PCBs, and DDT-derivatives during runoff and leaching of the landfill. The U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, is conducting environmental assessments to determine the effects of this contamination to wildlife. Patuxent Wildlife Research Center is cooperating with this effort by surveying amphibian species using the wetland and conducting a sediment bioassay on a selected Ranid.

Exotoxicology of Amphibians and Reptiles (task)

Donald Sparling

Collaborators: Greg Linder and Christine Bishop

The proposed book will consist of a compendium of synthesis chapters focusing on the ecotoxicology of reptiles and amphibians. SETAC Press has agreed to publish the book. Experts in particular fields have been identified to submit these chapters. A review board of additional experts will be selected. The book will review the physiology, ecology, and taxonomy and distribution of both vertebrate classes as these topics pertain to contaminant ecology and potential exposure to anthropogenic chemicals. It will then review specific topics of ecotoxicology including pesticides, organic compounds, metals, disease, and risk assessment in reptiles and amphibians. Throughout the book emphasis will be placed on the state of the science in each area, on identifying gaps in our knowledge, and pointing towards critical areas for future research. In some chapters both classes will be treated together whereas other chapters will focus on a single group. Although new, previously unpublished information will be presented as appropriate, we foresee that the majority of the chapters will interpret existing information into a ecotoxicological framework.

Although the effects of contaminants on reptiles and amphibians have been studied for decades, relatively little is known about these effects compared to the more intensively studied mammals, birds, and fish. Most of the papers which have been published on ecotoxicology in reptiles and amphibians are scattered throughout the peer-reviewed literature and many attempts to collect this information into a single body have stopped at the workshop or symposium level (e.g. the 1993 symposium on amphibian ecotoxicology sponsored by the Society of Environmental Toxicology and Chemistry or recent workshops on amphibian declines and deformities) without being published. This is in despite of growing worldwide concern for declining populations of both amphibians and reptiles, endocrine disruption and feminization of reptiles, and recent reports of widespread deformities in North American amphibians.

Effects of Organic Contaminants on Thyroid Function in Amphibians

Donald Sparling

The general objective of the study is to determine if environmental contaminants such as PCB, chlorinated hydrocarbon pesticides, or PAH can impair metamorphosis in anuran amphibians by interfering with the functioning of the hypophyseal-thyroid axis. The study will develop an assay for thyroid disruption using anuran tadpoles as models and screen candidate contaminants for potential effect on thyroid function. An initial step in this process will be to establish baseline growth and metamorphic responses of selected species of anurans to exogenous TSH and thyronine (thyroxin or T₄ and triiodothyronine or T₃) exposure. From this we will use known thyroid inhibitors to develop a protocol for testing additional chemicals. We will then screen candidate contaminants for their thyroid disrupting properties. After baseline information on the production of thyronines relative to stage of development and the possible effects of contaminants on thyroid functioning and metamorphosis have been elucidated under laboratory conditions, field work involving *in situ* experimentation and field surveys in contaminated and reference wetlands will be conducted to verify laboratory findings.

Completed

Modeling Regional Survival, Movement, and Recruitment Rates in Declining Metapopulations - Roseate Terns

Jeffrey A. Spindel, James D. Nichols, Jeffrey S. Hatfield

Collaborators: Ian C.T. Nisbet, President, I.C.T. Nisbet & Company; Joanna Burger, Professor, Rutgers University, Helen Hays, Director, Great Gull Island Project, American Museum of Natural History

New capture-recapture/re-sighting models will be developed to estimate between- population movement probabilities and to test hypotheses about sources of variation in these rates. Next, the relative contributions of different demographic rates (survival, movement, recruitment, reproduction) to metapopulation dynamics can be estimated, and an analysis can be done to determine if changes in some demographic rates are better predictors of local and overall population declines than are changes in other rates. The data used for model development and testing will be generated from a long-term cooperative study of the endangered northeastern breeding population of Roseate Terns (*Sterna dougallii*) because of logistic feasibility and immediate need for such information on this species.

Determination, Biological Consequences, and Modeling of Sex-Specific Demographic Rates in Declining, Threatened, or Endangered Metapopulations

Jeffrey A. Spindel, James D. Nichols

Collaborators: Ian C.T. Nisbet, President, I.C.T. Nisbet & Company; Jeremy J. Hatch, Associate Professor, University of Massachusetts-Boston; Joanna Burger, Professor, Rutgers University; Helen Hays, Director, Great Gull Island Project, American Museum of Natural History; David A. Shealer, Assistant Professor, Colgate University

Proper management of animal populations requires an understanding of both population dynamics and ecology, and more research that integrates population dynamics and ecological studies is needed to identify the causal factors involved in population declines, recoveries, and viability. The information being generated from such studies will allow managers 1) to identify "species-at-risk" earlier, 2) to begin management programs before populations decline to critically low levels, and 3) to pick the best sites for the establishment and/or restoration of highly productive, or "source" populations. New capture-recapture/resighting models will be developed to estimate sex-specific survival and between-population movement probabilities, and to test hypotheses about sources of variation in these rates. For highly mobile animals and birds, sex-specific survival and "between-patch" movements may contribute greatly to local "within-patch" dynamics, so the effectiveness of local management programs at National Wildlife Refuges and National Parks (and other sites, as well) must be evaluated within the context of overall population changes on a regional or "metapopulation" scale. Data for model development and testing will be generated from a productive ongoing long-term cooperative study of the endangered northeastern breeding population of Roseate Terns (*Sterna dougallii*) because of logistic feasibility and immediate need for such information on this species. The new work that will be done for this study will build further on the prior results of the adaptive research/monitoring metapopulation project of Roseate Terns at several sites including a FWS National Wildlife Refuge.

A Comprehensive Monitoring Program for Colonial Waterbirds

Melanie J. Steinkamp

Long-term conservation planning and management efforts for colonial waterbirds require the collection of species location and population trends over a broad geographic range spanning international boundaries. We are leading a cooperative effort to develop a monitoring program for colonial waterbirds in Canada, Mexico, and the United States. One component of the monitoring program will be a centralized data repository for colonial waterbirds. This data repository will support analyses of long-term trends of waterbirds and document population status and shifts in distribution. This information will help (1) document the present and future problems facing colonial waterbirds and, (2) better define the management actions necessary to support their long-term conservation.

Specifically, we propose to (1) develop and manage a centralized database that will disseminate data from multiple sources, (2) identify gaps in current survey efforts and coordinate the development of an integrated network of colonial waterbird population monitoring programs with States and Provinces in North America, (3) facilitate the development of standardized survey methodologies during the breeding and non-breeding seasons, (4) begin developing the framework necessary to monitor habitat at the regional and local scale, as related to colonial waterbirds, and (5) participate in the analyses of population trends once the database has been established.

Completed

Swallow-Tailed Kite (*Elanoides forficatus*) Habitat Requirements and Carrying Capacity for the Lower Suwannee Ecosystem, Florida

Paul W. Sykes, Jr., Cameron B. Kepler

Historically the Swallow-tailed Kite (*Elanoides forficatus*) bred in at least twenty states in the eastern United States from the south Atlantic coast across the northern Gulf of Mexico into Texas and north throughout much of the Mississippi drainage to Minnesota and Wisconsin. However, the kite currently is restricted to parts of seven southeastern states, with most of its breeding range in Florida. Causes for decline of the species are believed to be shooting, habitat loss, and habitat degradation. Breeding Bird Surveys indicate a declining trend of this Neotropical migrant in most of Florida. The lower Suwannee River, most of which is within the Lower Suwannee National Wildlife Refuge in the Coast Bend Region of Florida, appears to be very important for this raptor. Kites arrive from the wintering grounds during early March and are present until about mid-August. This study, to be conducted in the spring of 1997, will identify nesting habitats, estimate number of breeding pairs, and determine future carrying capacity of the Lower Suwannee ecosystem. This study is a Partnership Project between the Biological Resources Division and the Fish and Wildlife Service, Southeastern Region. A vegetation cover map, with the principal habitat components delineated (N ÷ 6 habitat types) will be developed from 1994 aerial false-color infrared photography at a scale of 1:24,000 in conjunction with USGS 7½-minute quadrangle maps and ground truthing. The cover map will then be used to plot localities where pairs of kites were observed in courtship, foraging, carrying nesting materials and food, perching, and nesting sites. Kites will be observed from above the forest canopy using an aerial lift (hydraulic) with basket (platform with safety railings) at pre-determined sites along roads within the study area. Height of the canopy ranges from 10 to 30m. Aerial lifts are available that reach a height of 46m. The extensive road system in the region is such that the entire study area, including all of the refuge, can be viewed adequately using binoculars from the observation platform on the aerial lift. The lift can accommodate up to three observers at a time. Results will guide the refuge staff in management for the species and be integrated into the overall management of the refuge and also be useful for management by the large private landowners in the region.

Management of the North American Bird Banding Program

John Tautin

Bird banding is a universal and indispensable technique for studying the movement, survival and behavior of birds. Data from banded birds are used in studying bird behavior and ecology, monitoring populations, restoring endangered species, studying effects of environmental contaminants and addressing issues of human health, safety and economy such as Lyme disease, bird hazards at airports, and crop depredations. Results from banding studies support national and international level avian conservation programs such as Partners in Flight, the North American Waterfowl Management Plan, and Wetlands of the Americas. Annually, approximately 1.2 million birds representing hundreds of species are banded in North America. About 75,000 are subsequently encountered and reported.

The Bird Banding Laboratory (BBL) is a service and administrative center for those who depend on banding for their work on migratory birds. BBL issues permits and bands; supplies forms, instructional materials and technical advice; coordinates use of auxiliary markers such as neck bands and radio transmitters; serves as the repository for banding records; serves as the clearing house for reports of banded birds; disseminates banding data to researchers and managers; and assists in the development and coordination of banding projects.

The Effects of Edge Habitat on Breeding Birds of Bottomland Forests

Daniel J. Twedt

Collaborators: Robert Hamilton and James Lind

The forests of the Mississippi Alluvial Valley have been highly fragmented, resulting in a landscape dominated by agriculture. Nest survival, predation, and parasitism rates of forest breeding birds are assumed to be negatively impacted by proximity to a forest-agriculture edge. Several studies have used artificial nests to test for these impacts. However, data from bottomland hardwood forests are lacking. Using 10 forest interior and 10 forest edge plots, we located and monitored open-cup nests to estimate survival, predation, and parasitism rates. In adjacent forested plots, we erected artificial nests and monitored their fates. Our objective is to estimate and compare demographic rates for edge and interior bottomland forests and to examine the relationship between predation rates of artificial and natural nests.

Completed

Use of Sarcophagous Terrestrial Invertebrates to Determine Wildlife Exposure to Pesticides

Nimish B. Vyas

We conducted three experiments on mortality pattern, dermal exposure, and post-mortem analysis using eastern screech owl (*Otus asio*) and American kestrel (*Falco sparverius*) exposed to carbofuran and fenthion to assist the Law Enforcement Division, U.S. Fish and Wildlife Service in their investigations. In experiment 1, a 1 d dietary test simulating typical contaminant consumption was conducted. Treatment levels were 63.4, 126.8, and 253.6 ppm carbofuran; 23.6, 47.25, 94.5, and 189.0 ppm fenthion. Experiment 2 involved a test for the reliability of pesticide residue levels in owl feet with respect to time. Residue levels in feet may serve as evidence of exposure during legal investigations. Experiment 3 is a test for the occurrence of pesticide residues in sarcophagous insects infesting carcasses of owls exposed to pesticides. Findings may provide an additional tool during legal investigations. Results imply that mortality pattern and brain cholinesterase activity depend on dose and rate of contaminant consumption and that the higher sensitivity of kestrels to carbofuran may be due to high affinity of their cholinesterase enzyme to the pesticide at neuromuscular junctions.

Organophosphorus Pesticide Effects on Migratory Orientation of Passerine Birds

Nimish B. Vyas

The objective of this study is to determine whether environmentally relevant levels of acephate exposure result in any detectable neuropathology within the avian brain. Immunocytochemistry was utilized using an antibody to avian choline acetyltransferase. Results show that neurons within the nucleus isthmi, pars parvocellularis (Ipc) were found to be significantly reduced on one side of the brain only. The Ipc is a nucleus that is a component of the visual system of birds, therefore, acephate is affecting some functional portion of the avian visual system. Since only one side of the brain is affected, an asymmetrical pathology of the brain has resulted. Impairment of the visual system may compromise the birds ability to migrate, forage, avoid predation, and return to the nest.

Toxicity of Selected Fire Retardant and Foam Suppressant Chemicals to Vertebrate and Invertebrate Species

Nimish B. Vyas

Wildfire control compounds are released into the environment by aerial and ground applications on rangeland, grassland and forest fires. The LD50s for all chemicals for the bobwhite and blackbird were > 2,000 mg/kg. The LD50 for kestrels exposed to Silv-Ex was > 2,000 mg/kg. LC50s for quail translated to operational application rates of 0.43% Silv-Ex solution in 2271.0 l water/139.4 m² and 1.6 kg Phos-Chek G75-F/9.3 m². No mortalities were observed in dietary tests with combusted test materials equivalent to the maximum operational application rates of 1.0% Silv-Ex solution in 2271.0 l water/139.4 m² and 5.1 kg Phos-Chek G75-F/9.3 m². Quail eggs exposed to Silv-Ex and Phos-Chek G75-F at 4 and 11 d of development resulted in significant ($p < 0.05$) decrease in hatching success at 1.6 kg Phos-Chek G75-F/3.8 l water. Acute oral and dietary toxicity testing on white-footed mice and prairie voles resulted in LD50 > 2000 mg/kg for both species and mortalities of mice at diets mimicking field applications rates of 1.4 kg Phos-Chek G-75F/3.8 l H₂O. No mouse mortalities were observed with diets up to 1% Silv-Ex solution. A two-generation reproduction test resulted in significant delay in onset of reproduction and fewer pregnancies ($P < 0.05$) for mice exposed to diets mimicking field application rates of 0.9 kg Phos-Chek G-75F/3.8 l H₂O/9.3 m². Data from a field test to evaluate the effects of operational applications of Phos-Chek G-75F and Silv-Ex are currently being analyzed. Some laboratory studies need to be repeated because of a water-borne disease outbreak in the animal colony in FY97.

Risk Quotient Field Validation Pilot Project for Selected Pesticides

Nimish B. Vyas

The U. S. Environmental Protection Agency (EPA) assesses risk to avian species from pesticide applications by generating a risk quotient and comparing it to a threshold level. If a risk quotient is greater than the threshold level, avian mortality is expected following field applications of the pesticide. Safety is assumed if the risk quotient is below the threshold. The risk assessment model used by EPA to assess risk to birds from pesticide applications has not been field validated. This study will test the ability of the risk quotient to predict hazard to birds from pesticide applications and monitor insecticide exposure to birds nesting in fruit orchards.

Lead Shot Exposure to Birds at a Trap and Skeet Range

Nimish B. Vyas

The objective of this study was to characterize the availability and exposure of lead shot to ground foraging passerines in woodland habitats surrounding a trap and skeet range. Brown-headed cowbirds (*Molothrus ater*) were first orally dosed with one or two shots (size 7¹/₂) to relate lead exposure to blood protoporphyrin. Although birds defecated the eroded shot in 2 to 5 d, protoporphyrin concentrations increased by approximately 300%. White-throated sparrows (*Zonotrichia albicollis*) housed in an outdoor aviary (12 x 18 x 1.8 m) located in the contaminated habitat showed significantly elevated blood protoporphyrin levels compared to pre-exposure levels ($P < 0.003$). Blood protoporphyrin values of free-flying dark-eyed juncos (*Junco hyemalis*) was significantly greater than that of birds from control site. This study is the first to document lead shot ingestion by passerine birds.

Effects of Prescribed Burning on Habitat Use and Reproduction of Neotropical Migrants in Areas Managed for Red-Cockaded Woodpeckers

Donald H. White

Collaborators: Brian R. Chapman, School of Forest Resources, Univ. of Georgia

The effects of prescribed burning on non-target species is poorly understood and has been identified as a high priority research need by Regional personnel of the U.S. Fish & Wildlife Service. This study is underway to determine if there is a difference in species diversity, richness, distribution, and reproduction of Neotropical migrants using recently-burned and not recently-burned mature pine forests managed for endangered red-cockaded woodpeckers (RCWs). The study location is Piedmont National Wildlife Refuge in north central Georgia. We are monitoring bird use and reproduction in tracts that were either winter-burned, summer burned, or not burned at all. Also, habitat features are monitored over time. To date, 375 nests over four field seasons have been monitored. Consistently, bird densities and diversity are greatest in two-year burn sites and fledging success is poor (~30-35 %) in all sites. Population parameters and productivity will be compared among burn regimes to test for habitat and time effects. Analytical results will be used to formulate management recommendations for the Refuge that will favor Neotropical migrants, as well as RCWs. Cooperators include U.S. Fish & Wildlife Service, Region 4; Piedmont National Wildlife Refuge; and The University of Georgia.

Completed

Development of a Camera System to Document Predation at Nests of Neotropical Migratory Songbirds

Donald H. White

Collaborators: Dan Stoneburner, Cam-Trak, Inc., Watkinsville, GA

Results of recent nest studies of Neotropical migratory songbirds in tracts managed for red-cockaded woodpeckers at Piedmont National Wildlife Refuge (NWR), Georgia, indicate a poor reproductive success rate (~35%). Causes of the poor success rates are uncertain, but depredation on nest contents is suspected. In most instances, the nest contents simply disappear, with little evidence of what took them. Infra-red cameras are limited in their usefulness, e.g., artificial nest studies, but are not appropriate for active nests where adults and chicks are moving continuously. In this study, we are developing proximity triggering mechanisms for the cameras that will record predators near nests, but will not record the activities of adults and chicks in the nests. At present, we are struggling with a moisture condensation problem on the triggering mechanisms, but we are confident that the problem can be resolved soon. Based upon evaluation of results and subsequent feasibility, management recommendations will be formulated to enhance productivity of songbirds at the Refuge.

Value of a Nest-Box Program for Hole Nesting Neotropical Migrants Utilizing Areas Managed for Red-Cockaded Woodpeckers

Donald H. White

The Carolina Sandhills National Wildlife Refuge, South Carolina, is intensively managed for red-cockaded woodpeckers (RCWs). A deleterious side effect of burning on a 3-5 year cycle is that dead cavity trees are practically eliminated, thereby severely restricting potential nest sites for certain hole-nesting songbirds. The great crested flycatcher (GCFL), a species of Regional concern, is present on the Refuge in spring, but may be limited in its ability to nest because of a paucity of natural cavities. Thirty nest boxes were randomly assigned to each of four burn regimes (120 boxes total) on the Refuge in February 1996. Throughout the breeding season, nest boxes were monitored weekly to document nest success. Eighteen pairs of GCFLs used our boxes this first field season. Fledging success was good, averaging ~90%. Only two nests were depredated, both by flying squirrels. The two-year burn site was preferred for nesting, but at least one nest box was used in each burn regime. Reproductive parameters from this 3-year study will be compared among treatments for differences. Snag counts will be correlated with nest box use as a measure of nest box importance. Information from this study will be used in developing management plans that benefit hole-nesting migrants, as well as RCWs.

Nest Success of Songbirds and the Effects of Cowbird Brood Parasitism at Big Bend National Park, Texas

Donald H. White

Numbers of brown-headed cowbirds (*Molothrus ater*) at Big Bend National Park (NP) have increased alarmingly in recent years. Data from the Breeding Bird Survey indicate a 1.5% annual increase during the last two decades. Bronzed cowbirds (*Molothrus aeneus*) also occur there, but in far fewer numbers. Mixed cowbird flocks are especially evident in the Park campgrounds during spring and summer. The incidence of brood parasitism and its effects on resident and migratory songbirds there are unknown, but there is growing concern that local nesting populations are being negatively impacted. Park biologists have identified this topic as a primary research need of the Park. In collaboration with the National Park Service, we will document nest success of songbirds at Big Bend NP over three seasons (1998-2000) to determine if brood parasitism is a real problem there. Nests under study will be grouped by year, species, selected habitat type (e.g., riparian zone, campground, mountain canyon, etc.), and incidence of brood parasitism and compared statistically for differences. Also, from bimonthly point counts, we will estimate cowbird densities in the selected habitat types and correlate these with productivity. As requested by the Park, we will identify Universal Transverse Mercator coordinates for all study nest locations using a GPS unit accurate to 2-5 m. Results will be used to formulate management recommendations for the Park that will enhance songbird recruitment. Until information on songbird reproductive success is available, Park officials will have no sound basis for implementing cowbird control measures, if needed.

Habitat Use and Abundance of Kentucky and Swainson's Warblers at Pee Dee National Wildlife Refuge, North Carolina

Donald H. White

The U.S. Fish and Wildlife Service has designated the Kentucky and Swainson's warblers as species of Regional concern. Census data indicate that these two Neotropical migrants have declined drastically in the southeastern U.S. There is a need to determine the abundance and habitat use of these two species on Service lands so that plans can be developed that will enhance their survival. Kentucky and Swainson's warblers are thought to occur on Pee Dee NWR, but there are no estimates of their numbers or preferred habitat types for the Refuge. Kentucky and Swainson's warblers will be censused weekly during summer of 1998 at Pee Dee NWR. Also, habitat types where birds are located will be recorded. Bird abundance will be correlated with habitat use so that management plans can be developed that will benefit these declining species.

Transferred to Dawson

Population Dynamics of Neotropical Migratory Birds Using Agriculture-Forest Mosaics in Southern Mexico

Marcia Wilson, Deanna K. Dawson, Chandler S. Robbins, John R. Sauer

Collaborators: Paul Wood and Mauro Berlanga, Pronatura, Peninsula de Yucatan

Concern about declining populations of several Neotropical migrants led to formation of an international conservation program entitled Partners in Flight. A major obstacle to this conservation effort has been the lack of information on the wintering grounds. Although general habitat associations have been documented for many species, much less is known about persistence and survival of migrants in various habitats. Complicating this is the rapid conversion of forests to pasture and other agricultural uses on the wintering grounds. In 1992, research was initiated on Rancho Sandoval, a private nature reserve in Campeche, Mexico. Bird populations were sampled with mist nets and point counts on six 12-ha study plots, three in forest and three in adjacent pasture. Over 11,000 birds of 158 species have been banded to date. Forty-two percent of the birds banded were migrants (47 species). For 12 migrant species, more than 20% of the banded individuals were captured in more than one sampling period. Recapture rates were higher for resident birds, exceeding 40% for 10 species. Data are being used to estimate survival probabilities and habitat/site fidelity for species, and to document temporal and spatial variation in the distribution, abundance, richness, and detectability of bird species. Results will enable us to evaluate the relative importance of these habitats to birds and to identify species most likely to be impacted by land use changes. This information is also being used to develop a conservation/management plan for Rancho Sandoval that protects and enhances habitats for migratory and resident birds.

Transferred to Dawson

Sustaining Wildlife Populations in Agricultural Landscapes

Cherry Keller, Marcia Wilson

Agricultural landscapes on the Eastern Shore of Maryland are generally composed of some mix of crop land, hayfields/pasture, wetlands, hedgerows, and forest wood lots. Presumably, the greater the amount of the landscape taken up by crop land, the less habitat is available for wildlife. Is this relationship linear? Is it linear for all habitats? What is the greatest "bang for the buck" in terms of providing the greatest habitat for wildlife in the most acreage efficient way? There are several Federal and State Programs that enhance habitat for wildlife on farmlands (e.g. Maryland Wildlife Habitat Improvement Program). They all involve removing some land (mostly marginal land) from crop land. Thus, the farmer has to evaluate the trade-offs. Most farmers are genuinely interested in providing wildlife habitat but, want to do this in a meaningful way without giving up large acreage. What amount is small enough to be acceptable to a farmer, but large enough to be of value to wildlife? What is the best placement of habitat improvement plots to enhance the overall wildlife diversity of the farm and the surrounding landscape? Wildlife managers implementing state and federal programs for wildlife enhancement need this type of information to make informed decisions and recommendations. Better models of the relationship between acreage in habitat versus crop land would allow us to understand where and how we can make the greatest gains in overall habitat value with the lowest acreage taken out of production.

Completed

Toxicity of Sediments from Dade County, Florida

Parley V. Winger, Peter J. Lasier

Quality of Biscayne Bay, Florida has declined markedly in recent years due to contamination from agricultural, industrial and municipal activities resulting in significant losses to fish and wildlife resources, recreational/tourist activities and commercial harvests. As part of a joint effort with NOAA, the State of Florida and Dade County to evaluate the severity, extent and sources of contamination to Biscayne Bay, we are determining the bioavailability of contaminants in the sediments from freshwater canals that discharge into the Bay. This is being accomplished by conducting toxicity tests on solid- phase sediments and pore water. Sediments were collected from the canals and shipped to the laboratory where *Hyalella azteca* were exposed to the sediments for 10 d in a water-renewal system. *Hyalella azteca* were also exposed under static conditions for 96 h to pore water extracted from the sediments. After exposures to the sediments and pore water, the animals were placed under UV light for 24 h to determine if they had been exposed to PAHs (photo- activation of higher molecular weight PAHs elicits increased toxicity). About 10% of the 95 samples tested were significantly toxic in solid-phase exposures. Toxicity increased to 30% of the samples after exposure to UV light. Pore water exposures were more sensitive, with 30% being toxic after 96 h. Exposure to UV light increased the number of samples showing toxicity to 55%. PAHs were suspected as the contaminant causing toxicity in over half of the samples showing toxicity. Efforts to improve water quality in Biscayne Bay should focus on areas that receive contamination from the petroleum products.

Completed

Effects of Industry and Dredge Spoils on Savannah Back River

Parley V. Winger, Peter J. Lasier

A portion of Savannah National Wildlife Refuge, South Carolina, is located along Back River of the Savannah River distributary system. Front River includes Savannah Harbor and associated industrial components. Front River is dredged on a regular basis with materials deposited in dredge spoils that are located within Refuge boundaries. Contaminants from the Harbor and Front River have the potential to reduce habitat quality in Back River through dredge spoils and dredge-spoil runoff and movement of water up the Back River during an incoming tide. Preliminary results from Quick Response Research (FY96) on the Lower Savannah River indicated that drainage and overflow from dredge spoils and industrial holding pond may be impacting habitat quality in Back River. Metal concentrations were elevated in dredge-spoil sediments utilized by nesting and feeding birds. Invertebrates collected from overlying water in the dredge spoil areas also had elevated metal concentrations, particularly mercury. To further evaluate the potential impacts of industry and dredge spoils on the environmental quality in Back River and the Savannah National Wildlife Refuge, sediment samples from the dredge spoils and Back River will be used in laboratory studies to determine bioaccumulation potential. Bioaccumulation potential will be determined by exposing *Lumbriculus variegatus* to the sediment for a period of 28 days. Sediment and pore-water toxicity testing will be used to identify additional areas in Back River and its tidal creeks that are impacted by dredge spoils and industrial holding ponds. Acute toxicity will be determined by exposing *Hyalella azteca* to the sediments for a period of 10 days.

Impacts of the Textile Industry on Georgia's Waters

Parley V. Winger, Peter J. Lasier

The textile industry in Georgia (and in the United States) is having a difficult time competing with foreign industry. The costs of doing business in the United States and Georgia are significantly higher than in less developed nations. Part of the problem is the cost of complying with permit requirements of effluents under Federal regulations (Clean Water Act). The State Legislature in Georgia requested assistance from the University of Georgia to help the textile industry be more competitive. As a result, a Consortium on Competitiveness in the Apparel, Carpet, and Textiles Industries (CCAATI) was formed by the University of Georgia and consists of scientists from several disciplines within the University community. We were asked by the head of the CCAATI project (Dr. Ian Hardin, Department Head, Textiles, Merchandising and Interiors) to be part of this working group. Our contributions are directed at identifying basic water chemical characteristics that influence effluent toxicity and provide insight into how these might be changed to improve effluent quality. Our initial studies demonstrated that NaCl used in the dyeing process was toxic in effluents at concentrations used. We also showed that salinity (NaCl) toxicity was reduced if basic water hardness was increased in softwater effluents. Additional work has shown that alkalinity is also important in salinity toxicity and that high alkalinities increase the toxicity. In addition, ozonation was found to be effective in the removal of dye color in textile effluents and toxicity was not increased. These basic findings have made a significant contribution in how effluents can be managed in order meet permit requirements. Future work will include toxicity identification evaluations of effluents to further define toxic components in textile effluents.